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Valuing the Economic Benefits of Conservation Lands in Downeast Maine

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VALUING THE ECONOMIC BENEFITS OF CONSERVATION LANDS IN DOWNEAST MAINE

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IN DOWNEAST MAINE

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Thesis Advisor: Dr. Mindy Crandall

An Abstract of the Thesis Presented
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Natural ecosystems provide numerous benefits that contribute to humans and the economy, including market goods such as timber and forest products, as well as benefits that are not directly measured in the marketplace, such as wildlife habitat provision and recreational provision. These benefits are collectively known as ecosystem services. Natural ecosystems are under significant pressure to be converted to other uses from factors such as shifts in ownership, land use change, fragmentation and climate change. To counter these effects, and to protect ecosystem services, public and private entities have worked to place land in conservation; however, conservation is often controversial due to a number of factors, including a loss of property tax income, and real or perceived loss of access to the land. Concerns about the value of conserved land can put stakeholders at odds. Economic valuation of ecosystem services is in demand and contributes to land use and policy decision-making. The objective of this study was to assess the economic value, in real 2017 dollars, of the ecosystem goods and services provided by conserved lands in the Downeast Maine region. Benefit transfer was used to value the following nonmarket ecosystem services: recreation, science and education, water provision, water purification and wildlife habitat. Market-based economic methods were applied to measure the contribution of timber, wild blueberries, and carbon sequestration on conserved lands in the study area. This study mapped and valued ecosystem services on conservation lands in Downeast Maine by applying established replicable methodology that will have practical applications for land managers and policy makers, in order to better understand the use and value that conserved lands contribute to the economy of the region. Study results showed that conservation land in the study region provided $463M in ecosystem service benefits in 2017, with an average of $653/acre/year. An outreach and communication plan for sharing this study with a wide range of stakeholders is provided to maximize operationalization of these results.

DEDICATION

For Stephanie.

And for Stephania.

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1.1 Ecosystem Services and Their Benefits to Society

Natural ecosystems provide numerous goods and services that contribute to both human well-being and the economy (Costanza et al., 1997; Daily, 1997; Troy & Wilson, 2006; Braat & deGroot, 2012). This "natural capital" is essential to quality of life and includes such market goods as drinking water, timber, agricultural products, fish, and shellfish. It also includes services that are not measured in the marketplace, such as flood mitigation, carbon sequestration, and wildlife habitat.

The term "ecosystem services" was first adopted by Ehrlich and Ehrlich (1981) to describe these natural amenities that provide benefits to humans. In 2005, the Millennium Ecosystem Assessment (MEA, 2005) further advanced the concept of ecosystem services. The group proposed a classification system dividing ecosystem services into four categories: provisioning (e.g. timber, water, crops), regulating (e.g. flood mitigation, climate regulation), cultural (e.g. recreational, educational, spiritual or aesthetic benefits) and supporting – those services which enable the production of other services (e.g. nutrient cycling, soil formation). Ecosystem services occur at widely different spatial scales, and there is variation in the scale at which they impact human welfare (Troy, 2012). For example, carbon sequestration benefits individuals on a global scale, whereas blueberry harvests benefit individuals on a local scale. In addition to benefits accruing to individuals, ecosystem services also benefit the local economy both directly and indirectly; direct benefits typically come from provisioning services, while indirect economic benefits may arise from cultural services (e.g., through visitor spending effects offered by ecotourism, or employment provided by land preservation efforts).

This study uses an ecosystem services approach to calculate the economic value of conservation lands in Downeast Maine, an area composed of Hancock and Washington Counties. This region, roughly bordered by the Atlantic Ocean, the Penobscot River, and Canada, includes extensive coastline, thousands of acres of forestland, areas of agricultural land, mountains, lakes, rivers, and wetlands. The area is known for its recreational and aesthetic resources, and productive offshore areas. Employment centers range from the tourism-dominated area of Bar Harbor in Hancock County, adjacent to Acadia National Park, to the Baileyville tissue mill and Woodland pulp mill area in Washington County. Overall, it remains one of the least developed areas of Maine.

Natural ecosystems are under pressure to be converted to other uses, and the Downeast region of Maine is no exception. Shifts in ownership, land use change, fragmentation of land cover, and climate change are all major factors affecting the future of the region's ecosystems. Partly in response to increasing pressure or risk of development, and to preserve the production of ecosystem services from these lands, private and public entities have worked to place land under conservation. Across the Downeast region, 19.6% was held in some type of conservation status in June 2017 as defined by this study.

1.2 The Downeast Economy

In a report on the State of Maine's Environment, Hassan et al. (2010) found significant differences in socioeconomics and demographics between the two counties in Downeast Maine. Hancock County's population has increased over time, and has average per-capita income and education rates that are comparable to, or exceed, Maine's state average. Hancock is one of Maine's fastest growing counties, largely driven by tourism (Barringer, 2010; US Census, 2009). Washington County, however, has seen a decreasing and aging population, high unemployment, and average income and education rates below those of the rest of the state. Hassan et al. (2010) found this region to have the highest unemployment rate and the lowest per capita income in the state. Forestry, fishing, and tourism were reported as the primary employment sectors in the Downeast region. However, the forestry sector in Maine has seen a decline, particularly since 1990, with low returns motivating land owners to convert toward other uses (Hassan et al., 2010).

Across the United States, rural economies have shifted and transformed over recent decades, no longer resembling the communities of 100 years ago. Over the past 30 years, employment in many natural resource-based industries, including forestry and fishing, has declined (Hassan et al., 2010; Safford & Hamilton 2012). Irwin et al. (2010) reviewed economics literature over the past century to assess changes in rural development and regional issues. They found that the shifts in rural regions reflect national trends, where employment in the service sector has grown while manufacturing jobs have continued to decrease. In rural areas, employment in natural resource extraction and agriculture was predominant in the past, but today's rural economies are much more diverse, due in part to demographic shifts (Safford and Hamilton, 2012).

This transition from a resource-based economy to a service-based one is evident in the Downeast region. Hassan et al. (2010) found that tourism and the service sector have recently shown the most growth in employment in Downeast Maine. While tourism is particularly strong in Hancock County, remote Washington County still relies heavily on natural resource industries.

1.3 Conservation in Downeast Maine

There are varying public perceptions of conservation land. Local communities are often resistant to establishing land use limitations, such as the deed restrictions on development accompanying conservation easements, and they often fear potential loss of current and future property tax income for their town (King & Anderson, 2004; Korngold, 2007). This perception that the lost tax revenue exceeds the value of the conserved land has frequently placed conservationists and residents at odds. However, in a 2018 report on conserved lands owned by nonprofits in Maine, the Maine State Legislature's Joint Standing Committee on Agriculture, Conservation and Forestry found that private land trusts provide significant public benefits, including protecting resources critical to the state economy. They concluded that Maine's land trusts offer a wide range of benefits to the general public that municipal and state governments would otherwise need to provide, including access to recreational fishing and hunting, snowmobiling, hiking, camping, and more.

Lands in conservation have had use restrictions placed on them "in perpetuity", primarily restrictions on development. For the purposes of this research, conserved lands include public lands held in conservation (federal, state, county and municipal) such as lands owned by the National Park Service (NPS), US Fish and Wildlife Service (USFWS), and the Maine Bureau of Parks and Lands (MBPL).

Examples of **public** land units include Acadia National Park, Moosehorn National Wildlife Refuge, Quoddy Head State Park, Roque Bluffs State Park, and Lamoine State Park. Conserved lands also include **privately-held** conservation easements on private lands, and lands under private fee ownership by nonprofit land trusts and other conservation organizations (e.g. Downeast Community Forest).

A **land trust** is a nonprofit organization that, as all or part of its mission, actively works to conserve land by 1) acquiring land or conservation easements (or assisting with their acquisition), and/or 2) stewarding/managing land or conservation easements.

A **conservation easement** is a voluntary legal agreement between a landowner and a land trust or government agency that permanently limits uses of the land in order to protect its conservation values. Landowners retain many of their rights, including the right to own and use the land, sell it and pass it on to their heirs. Lands may also be conserved by an outright purchase known as **fee acquisition.** (Land Trust Alliance, 2018)

Whereas the western U.S. holds large tracts of land in outright public ownership, just 6.5% of Maine is public land (State of Maine Joint Standing Committee on ACF, 2018). The State of Maine Report (2007) emphasizes the importance of land trusts in protecting lands for public use. When lands are conserved by nonprofit land trusts, they qualify for a property tax exemption. However, the Standing Committee on Agriculture, Conservation and Forestry (2018) reports that the bulk of private lands conserved in Maine are enrolled in Maine's Tree Growth Tax program, which may be managed for commercial harvest and provides municipalities with up to a 90% reimbursement of this lost tax revenue (Maine Revised Statutes Title 36, section 578).

The Downeast Conservation Network (DCN) is a coalition of organizations and agencies that connects conservation, research, education, and people in Downeast Maine. In an effort to better understand the value of conservation land in the region, DCN contacted researchers at the University of Maine to initiate a research project that would more comprehensively assess the economic contributions of these lands to the surrounding communities. To our knowledge, this is the first such economic valuation of conserved lands conducted specifically for the Downeast Maine region.

1.4 Ecosystem Service Valuation

One of the basic tenets of economics is that resources are scarce (Hanley et al., 2013; Mankiw, 2015). Society has limited inputs to any production, and cannot produce all of the goods and services demanded by people. Economics is essentially the study of how people manage these scarce resources. Valuing ecosystem services demonstrates that environmental resources are also limited, and that their loss comes at a price to society (TEEB, 2010).

Economic valuation of ecosystem services has been identified as a tool to inform policy and land-use decisions, helping decision makers evaluate trade-offs and synergies in policy and management scenarios (Posner et al., 2016). In 1991, Costanza coined the phrase "ecological economics" which defined the integration of ecology and economics. Costanza et al. (1997) launched the concept into the spotlight with their seminal research valuing the world's ecosystem services and natural capital. Although later met with criticism for its broad assumptions, Costanza et al.'s work brought natural capital valuation into the mainstream. Since that time, there has been a proliferation of methods, concepts, and case studies linking the natural environment with the economy (Braat & deGroot, 2012).

The two general economic categories of ecosystem services are market (those that can be bought and sold) and non-market. Throughout the 20th century, efforts primarily applied market methodologies to determine the value of certain ecosystem services that were traded in the marketplace. However, this meant that non-market ecosystem services were excluded and essentially received a dollar value of zero, putting this natural capital at risk and inadequately assessed in benefit-cost analysis (Braat & deGroot, 2012; Dupras et al., 2015; Richardson et al., 2015). Capturing the value of non-market ecosystem services was an important goal of this analysis. Over the past decade, research in the valuation of non-market ecosystem services has expanded exponentially, as the demand for this information by policy-makers and land managers has grown.

There are multiple ways to conduct economic analyses, but common to all economic valuation methods is their theoretical foundation in the principles of welfare economics. The value of something can be described as what we are willing to give up to get it. Hanley et al. (2013) explain the application of cost-benefit analysis to environmental valuation, which assigns value in terms of marginal social cost or marginal social benefit. This information may be revealed in the marketplace for such benefits as visitor spending, employment, or the value of a crop harvest. Non-market benefits, such as the value of wildlife habitat or access to recreation, must be measured by applying non-market techniques, such as derived measures of willingness-to-pay (WTP).

1.4.1 Valuation of market goods and services

Certain benefits offered by natural ecosystems can be measured directly in the marketplace. Direct market approaches use data from actual markets, with prices reflecting individual preferences (TEEB, 2010). Many provisioning services (such as timber harvests) can be valued by applying direct market valuation approaches, which include market price-based approaches, cost-based approaches (reflecting the cost if an ecosystem service needed to be recreated), and production function-based approaches (which determines how an ecosystem service contributes to the value of a commodity that is traded in the marketplace).

Mankiw (2015) explains that rational people think at the margin. In other words, decisions are often based on comparing marginal benefits—or the benefit that one extra unit of a good would yield. A person's willingness to pay for a good (WTP) is based on marginal benefit, which means the value depends on how many units of the good a person has already acquired.

WTP is further complicated by the *ability* to pay, and will vary based on income distribution (Hanley et al., 2013; Shaffer et al., 2004).

In a functioning economy, market price-based approaches represent both preferences (marginal benefit) and the marginal cost of production. This is reflected in a commodity's price, which when multiplied by the marginal product of that ecosystem service, provides an indication of its value (TEEB, 2010).

1.4.2 Valuation of Non-market Goods and Services

More recently, global, regional, and local environmental assessments of non-market goods and services have applied cost-benefit analyses (Braat & deGroot, 2012). To determine the economic value of non-market goods and services, different methodologies are applied based on what is being measured. Willingness to pay (WTP) and willingness to accept compensation (WTA) are two measures of economic value that have been frequently applied to quantify non-market ecosystem services in primary research. In this case, WTP is assessed not through direct observation of market prices, but by various methodologies explained below. WTA refers to a person's stated willingness to accept compensation for the loss of a non-market good or service.

Cost-benefit analysis tools include revealed and stated preference approaches. Revealed-preference approaches look at actual choices revealed by consumers in the marketplace, based on past behavior. For example, the hedonic pricing method evaluates the housing market to identify WTP to live near environmental attributes, whereas travel-cost models evaluate time and money expenditures made while participating in recreational activities to determine the implicit value placed on the activity. To capture the value derived from visitor spending as a result of visitations to conservation lands Downeast, a modified Visitor Spending Effects (VSE) approach was used (Cline et al., 2011). VSE are the direct and ripple effects of visitors' spending money on employment and business activity in gateway economies surrounding parks (Koontz et al., 2017).

However, not all preferences are revealed even indirectly in the marketplace. Many non-market goods and services must be valued by applying a stated-preference approach. This tool applies survey methodology to query respondents about their WTP for an environmental benefit, or their WTA compensation for the loss of an environmental benefit. Production function approaches value non-market changes in the quality of the environment by evaluating increase or decrease in the cost and output of some market-measured good or service (Hanley, 2013).

1.5 Valuing Conservation Lands in Downeast Maine

This research was originally requested by the Downeast Conservation Network (DCN) to generate information for assisting citizens, municipalities, planners, policymakers, conservationists, and landowners as they consider issues of land use, property taxes, development, and conservation of land in the region. In particular, this study seeks to better understand the use and value that conserved lands contribute to the economy and human well-being of residents of Downeast Maine. This project includes both market and non-market valuation of a select group of ecosystem services, as determined by key stakeholders.

The primary goal of this study was to map and value current (2017) conservation lands in Downeast Maine by applying established, replicable methodology that will have practical applications for land managers and policy makers. This thesis first describes the GIS mapping of the study area, including classifying and mapping of land use and land cover, identification and mapping of conserved lands in the study area, and mapping demographic and socio-economic characteristics of the region. Next, an economic valuation of ecosystem services provided by these conserved lands was estimated using benefit transfer valuation of non-market ecosystem services, direct valuation of market-based ecosystem services, and calculations of visitor spending effects and employment contributions to the local economy. Finally, a communication and outreach strategy for sharing of the results of this study with a range of stakeholders is provided. The outreach strategy provides guidelines for maximizing the operationalization of this economic valuation methodology in applied community settings.

CHAPTER 2 METHODS FOR MAPPING AND VALUING ECOSYSTEM SERVICES

The framework applied to this study was a stakeholder-driven valuation of select ecosystem services. Central to the project was geographic information system (GIS) mapping of the land use / land cover, conserved lands, and socioeconomic / demographic characteristics of the study area. Measurement of non-market ecosystem services was grounded in benefit transfer methodology, as described by Troy and Wilson (2006), and applied statewide to Maine by Troy (2012). Direct calculations were performed on a small number of provisioning services which can be measured in the marketplace (e.g. blueberries and timber). Finally, the economic contributions offered by employment and visitor spending in the region were also calculated. The steps are outlined in Table 2.1 below.

Table 2.1. Study Methods

Step 1	Map the study area a. Map all conserved lands in the study region b. Map land use / land cover of conserved lands c. Map demographic and socioeconomic variables for the two-county region
Step 2	Develop a stakeholder-driven, customized typology of priority ecosystem services
Step 3	Non-market analysis: Calculate values of priority non-market ecosystem services applying benefit transfer methodology as described by Troy and Wilson (2006)
Step 4	Market Analysis: Perform direct calculations for identified market-based ecosystem services
Step 5	Calculate employment and visitor spending effects

2.1 Mapping

Maps are often used to conceptualize ecosystem services (Hauck et al., 2013). The mapping of ecosystem services has increased significantly over the last decade, and is now becoming mainstream (Crossman et al., 2013; Burkhard & Maes, 2017; Wright et al., 2017). Maps serve as tools for planning and land management decision-makers, providing spatial information on the distribution of ecosystem services within a region. Maps have the potential to facilitate decision-making, expand stakeholder awareness and engagement, and to reveal linkages between ecosystem services and their associated beneficiaries, provided that certain requirements are met, and challenges overcome (Andrew et al., 2015; Nahuelhual et al., 2015). In their introduction to a special issue of the journal *Ecosystem Services*, Willemen et al. (2015) identified best-practices for ecosystem service mapping which included i) transparency, ii) robustness, and iii) stakeholder relevance. Troy and Wilson (2006) emphasize the importance of identifying accurate boundaries, and making small adjustments as necessary, as the results will have a significant impact on final ecosystem service valuation. Sousa et al. (2016) point out that approaches to mapping and classification of ecosystem services must take into account socio-cultural and demographic characteristics, forms of governance, biophysical characteristics, and scale of analysis.

A wide range of ecosystem service mapping methods exist, and they vary significantly in their complexity and data requirements (Martinez-Harms & Balvanera, 2012; Andrew et al., 2015.) Several authors have identified inconsistencies in terminology as causing uncertainty in methodology choice and in determining what has been mapped (Crossman et al., 2013; Englund et al., 2017). Ecosystem service mapping methodologies are often grouped into three general categories: 1) primary, data-intensive, direct mapping based on survey research, 2) empirical models such as InVEST (Integrated Valuation of Ecosystem Services and Trade-offs) or ARIES (Artificial Intelligence for Ecosystem Services), and 3) a priori rule-based models, such as spatially-explicit benefits transfer (Willemen et al., 2015; Eigenbrod et al., 2010). Andrew et al.

(2015) and Englund et al. (2017) expand this categorization to include extrapolation and data integration methods. Working under the auspices of the University of Maine at Machias GIS Laboratory, a spatially-explicit benefit transfer mapping process was conducted for this study using ArcGIS software (ArcMap 10.4.1). Benefit transfer was selected as the methodology after a comprehensive review of cost-benefit tools as it can be applied in settings of limited data, limited resources, and under time constraints, making it applicable in applied settings.

2.1.1 Mapping Land Cover

As pointed out by Eigenbrod, et al. (2010) one of the greatest challenges to advancing the practice of ecosystem service valuation is the lack of primary data on which ecosystem services exist on each area of land. As a result, land use/land cover data (LULC) has become a frequently applied proxy for mapping ecosystem services (Seppelt et al., 2011; Andrew et al., 2015). LULC maps are widely available, offered at different scales, provide detailed information and are user-friendly. Each land cover type can be associated with a unique set of ecosystem goods and services (Table 2.2). The application of a certain land cover class to a specific ecosystem service is a limitation in the methodology, however, as it requires the assumption that land cover classes are spatially and temporally homogeneous. Additionally, there are multiple approaches to classifying land cover and building LULC databases; the LULC map typology can significantly influence patterns across space (Witham et al., 2015).

For this project, LULC data from the USGS National Land Cover Database (NLCD) was applied to create a land cover typology of the study area. The NLCD is a land cover map that quantifies features at a 30-meter spatial resolution, and was most recently updated in 2011. (The Maine Land Cover Database [MELCD] layer is available at a 5-meter resolution, but had not been updated since 2004.) To create a LULC layer of the study region, we first downloaded the

2011 NLCD raster layer, which was then clipped to Washington and Hancock Counties in Maine. The layer was converted to a vector (polygon) file and re-projected to the Universal Transverse Mercator projection, Zone 19N (NAD 1983). The resulting land cover polygons were clipped to encompass conserved lands only.

Table 2.2. Land cover types as proxies

Land cover type	**Examples of Ecosystem Services Provided**
Deciduous Forest	Air pollution removal, carbon sequestration, water quality protection, erosion control
Woody Wetland	Water quality, wildlife habitat, flood mitigation
Evergreen Forest	Air pollution removal, carbon sequestration, carbon storage, water quality protection/erosion control
Pasture/Hay	Biodiversity/habitat, livestock/ livestock products, and pollination services
Shrub/Scrub	Biodiversity/habitat, carbon sequestration
Cultivated Crops	Flood protection
Emergent Herbaceous Wetland	Water quality and habitat
Mixed Forest	Air pollution removal, carbon sequestration, carbon storage, water quality protection/erosion control
Open Space/Parks	Air pollution removal, carbon sequestration, stormwater management
Grassland/Herbaceous	Carbon sequestration, biodiversity/habitat, and pollination services
Open Water	Freshwater regulation and supply, wildlife habitat

Although a fine resolution was used to minimize generalization error, once clipped to the study region, the scale of the land cover classification layer was still not specific and spatially precise enough for the desired level of analysis for some cover types. For example, cultivated blueberries and beaches were not captured on the NLCD layer. To further refine the map, the

LULC layer was augmented by overlaying 1) public beaches on conserved lands, and 2) areas of cultivated blueberries greater than 40 acres, derived from an analysis of satellite imagery.

Public beaches on conserved lands were first identified using Google Maps. Using aerial base map images in ArcGIS, each public beach was then manually digitized to create polygons outlining the beach from the wetted surface upland to the high water mark and added to the conserved land layer. Once added, the beaches increased the overall area of conserved land by 30 acres.

The layer depicting blueberry barrens of 40 acres or greater was created using 2013 Landsat multispectral imagery. To extract the barrens, a supervised classification was conducted at the University of Maine at Machias GIS Laboratory by Christopher Federico on behalf of the Downeast Salmon Federation. Barrens of 40 contiguous acres or more were assumed to be purposely cultivated and of commercial size, based on observations both in aerial imagery and on the ground. For the present project, where the blueberry barrens overlapped conserved lands, the NLCD land cover classifications were overridden by blueberry barrens of 40+ acres. These totaled 3,594 acres in the study region. Ground-truthing was conducted for verification purposes. Although the approach was labor intensive, results were more locally relevant and site specific.

2.1.2 Mapping Conserved Lands

To create an up-to-date layer of conserved lands in the Downeast Maine region, the State of Maine conserved lands layer was downloaded from the Maine Office of GIS (MEGIS) as a basis for creating an updated layer. The state's original conserved lands map was produced in 1989, updated in 1993, and data is now updated monthly (MEGIS, 2018). The file is meant to be viewed at a 1:24,000 scale, and includes conserved lands for Maine held in federal, state, municipal, and nonprofit ownership and/easements. Township boundary data were obtained from MEGIS town boundary dataset (METWP24; updated August 24, 2016).

When a new conservation easement is signed, or a new fee acquisition of a parcel completed, the reporting of these conserved lands to the State of Maine is voluntary, and the rate of participation varies by organization. Some entities in Maine reported sharing all of their conserved land data with MEGIS. Others only share conservation easements, and some do not report at all. For this reason, we opted to contact conservation landholders in the region to request sharing of shapefiles to update and validate the state conserved lands layer.

During the spring of 2017, conservation landholders in the study region were contacted individually by phone and/or email to request permission to use their current conserved land shapefiles for this project. Participating organizations included The Nature Conservancy, Maine Coast Heritage Trust, Downeast Salmon Federation, Blue Hill Heritage Trust, and Crabtree Neck Conservancy. Newly conserved lands and missing parcels that did not appear on the State of Maine's conserved lands layer were added to the MEGIS conserved lands layer.

The parcel data received varied considerably in terms of accuracy and information being tracked. Discrepancies in parcel boundaries were identified and corrected with best available information. An additional 141 conserved land parcels were added from shapefiles received from participating organizations. A map error correction was then conducted in which 155 errors were identified and corrected (e.g. duplicate entries removed, conflicting ownership reconciled).

Once the conserved lands layer had been updated, a union of the LULC and conserved lands layer was conducted, and a dissolve was performed based on classification fields to create a new layer showing conserved lands by LULC classification. A model was then created in

ArcMap 10.4 to calculate the number of conservation land acres in each land cover class, parsed by conservation and holder types, as well as by county.

2.1.3 Mapping Demographic and Socioeconomic Characteristics

Another important aspect of this study was the creation of a series of demographic and socioeconomic maps of the study region. By mapping the socio-economic context within which the ecosystem services lie, and characterizing likely users, we can proxy ecosystem service demand. However, some ecosystem service beneficiaries may be distant from the source of the service (Fisher et al., 2009; Andrew et al., 2015). One example would be the benefits of carbon sequestration which are realized by users both near and far from the ecosystem service provision.

The characteristics of the surrounding population also impact both the demand of and value of local ecosystem services. Luck et al. (2009) found that poverty increased the demand on ecosystem services, whereas Ghermandi and Nunes (2013) report ecosystem services receive a higher monetary valuation in wealthier economies. Multiple studies have reported the influence of stakeholder group as well as demographic and socioeconomic influences on ecosystem service demand, supply, and value estimates (Andrew et al., 2015; Saphores & Li, 2012; Sherrouse et al., 2011; Waltert & Schlapfer, 2010).

Demographic and socioeconomic data for Hancock and Washington Counties were obtained from the US Census Bureau's Decennial Census (2000) and American Community Survey (US Census ACS, 2016) products. County-subdivision level data, roughly equivalent to the township level, for the two-county region (Hancock and Washington) from 2000 and 2016 was downloaded from the American Fact Finder website. (The 2016 ACS includes data from a five-year survey period for low population areas such as these. The margins of error for the data are not mapped, but can be quite large for low population areas; caution is recommended in interpreting the values displayed.) Data included population, percent of population over 25 years of age with at least a high school diploma, percent of population over 25 years of age with at least a bachelor's degree, labor force participation rate (percent of the population between 16 and 65 years of age who are working or looking for work), unemployment rate, median household income, percent of the population in poverty, the percent of the population under 18 in poverty, the total number of housing units, the number of housing units occupied, and the number of vacant housing units for vacation or seasonal purposes. Choropleth maps were created in ArcMap 10.4.1 to illustrate the distribution of these characteristics in the study area, and the change in select characteristics over time.

2.2 Developing an Ecosystem Services Typology

2.2.1 Stakeholder Conversations

This project was stakeholder-driven from the early stages of conceptualizing the study. Relevant stakeholder identification is a critical part of ecosystem valuation (Hein, et al., 2006; TEEB, 2012). The process is inherently value-laden, as the significance of ecosystem services depends on who is benefitting from them. When conducting an ecosystem valuation, Hein et al.'s (2006) definition of a stakeholder is "any group or individual who can affect or is affected by the ecosystem's services" (p. 213).

Inclusion of stakeholders is essential at each step to maximize the legitimacy (fairness), salience (relevance), and credibility (believability) of the work. Hein et al. (2006) found that ecosystem services are valued differently by stakeholders at different scales. For example, they found that recreation is more relevant at a local scale whereas wildlife conservation was more relevant at a national scale. TEEB (2012) points out that stakeholder-oriented approaches allow for evaluation of trade-offs (who “wins” or “loses”) of different management strategies, thereby helping to minimize conflict in the decision-making process.

Stakeholder identification was initiated by meeting with members of the Downeast Conservation Network. As recommended by Darvill and Lindo (2015), stakeholders with a wide range of ecosystem service applications and needs were included. Representatives from local land trusts, statewide and federal conservation organizations working in Maine, regional economic councils, government agencies, and the Passamaquoddy Indian Nation were asked to share what, if anything, they would like this study to answer or address regarding conservation land in the Downeast Maine region, and to determine which ecosystem goods and services were of priority interest for further exploration and economic valuation.

Conversations were held with 12 individuals representing 8 organizations (nonprofit, municipal, state and federal) in March of 2017. Meetings were conducted in person and by telephone. Individuals represented local land trusts, statewide and federal conservation organizations working in Maine, regional economic councils, government agencies, and the Passamaquoddy Indian Nation. Ecosystem services of relevance to the region and those identified through conversations were used to guide which values would be represented in the valuation process. The stakeholder generated priority ecosystem services for analysis are detailed in Table 2.3. Final ecosystem service values calculated were limited to appropriate data availability for the benefits transfer methodology.

Stakeholders shared a range of potential study goals, and offered their opinions of the most significant ecosystem services in the region. There was a strong interest in calculating the number of jobs provided by conservation in the study area. Priority ecosystem services identified by stakeholders included maintaining access to native fishing grounds, ensuring the provision of fish and wildlife habitat including anadromous fish passage, and preserving land for access and economic activity. Concern was expressed about the declines of sea run fish and the warming of water in the St. Croix River Watershed, salt marsh decline, and preserving lands for future value. Several stakeholders shared that much of the local tourism economy depends on access to these conserved lands. Questions were identified and ecosystem services collated by priority.

2.2.2 A Customized Typology

Applying stakeholder interests, and similar to Troy (2012), a customized typology of ecosystem services was created for the Downeast study region. Based in concept on the Millennium Ecosystem Assessment classification scheme, this typology was constrained by data availability. Therefore not all identified priority ecosystem services could be evaluated. Specifically, data was unavailable to conduct an economic valuation of healthy lifestyle, salt marsh health, preserving land for future generations, soil retention, rockweed harvesting, and healthy riparian zones.

The following non-market ecosystem services were assessed: recreation (access to areas with migratory fish, recreational angling, non-motorized boating, water quality, camping, deer hunting, moose hunting, and bear hunting); science and education provision (conserved lands serving as classrooms); provision of wildlife habitat; water supply (forests provide natural infrastructure for carrying and transporting water); climate mitigation through carbon sequestration; clean water; and beach access. Direct market values were also determined for a select group of market-based ecosystem goods. These included tourism visitor spending, conservation employment in the region, direct value of harvested blueberries (barrens of at least 40 acres were assumed to be harvested), and direct value of harvested timber and wood fiber. The type of service attributed to each land cover type is detailed in Table 2.3.

Table 2.3. Stakeholder-identified priority ecosystem services

Stakeholder group (# reps)	**Priority Ecosystem Services**
Local land trust representative (3)	Wildlife habitat, Recreation, Tourism, Healthy lifestyle, Salt marsh health, Preserving land for future, Water quality, Soil retention, Access, Economic activity
State government representative (3)	Rockweed harvesting
Regional conservation organization representative (2)	Fish habitat, Fish passage, Clean water, Value of angling
Federal government representative (1)	Wildlife & waterfowl habitat, Wildlife tourism
Regional economic council representative (1)	Healthy riparian zones and fisheries, Tourism
Tribal representative (1)	Fish & wildlife habitat, Fish passage, Clean water, Access to resources

Table 2.4. Stakeholder-identified Priority Questions

Stakeholder group (# representatives)	**Priority Questions**
State government representative (3) Federal government representative (1)	What is the purpose of a conservation parcel?
Statewide land trust representative (2) Regional conservation organization representative (2)	What is the contribution of conservation employment to the study region?
Regional economic council representative (1)	What is the cost of taking conserved lands off the tax rolls?

Table 2.5. Ecosystem services provided by various land cover types

Land Cover Type	**Ecosystem Service(s)**
Open Water	Recreation - access to area with migratory fish Recreational fishing: fresh & salt Recreation - non-motorized boating Recreation - water quality Wildlife habitat - migratory fish spawning habitat
Forest	Carbon sequestration Recreation - camping Recreation - deer hunting Recreation - moose hunting Recreation - black bear hunting Timber Water supply
Scrub/Shrub	Blueberry production Carbon sequestration Recreation - deer hunting
Grassland / Herbaceous	Recreation - deer hunting
Pasture / Hay	Recreation - deer hunting
Cultivated Crops	Recreation - deer hunting
Wetland	Carbon sequestration Clean water Recreation - deer hunting
Beach	Recreation access
Acadia National Park	Recreation access Science and education

2.3 Valuation of Non-market Ecosystem Services Using Benefit Transfer

Certain services provided by ecosystems, such as wildlife habitat provision or recreation access, cannot be measured using traditional economic means. In these cases, value can be determined by assessing an individual's WTP for the benefit of a given ecosystem service. As pointed out by Bockstael et al. (2000) and Plummer (2009), value is not intrinsic to an environmental location or ecosystem service, but rather is assessed within its own particular context by a range of stakeholder groups.

When conducting a valuation of ecosystem services, primary research (e.g., study-specific surveys) is the ideal. However, conducting primary research is often very time-consuming and cost-prohibitive. Benefit transfer (also known as “value” transfer) has become a preferred secondary method for practical application in the field, as it is relatively inexpensive, can be conducted in a timely manner, and is less data-intensive (Troy and Wilson, 2006; Plummer, 2009; TEEB, 2012). Additionally, the process is transparent (Andrew et al., 2015; Koschke et al., 2012) and a wide range of spatial indicators exist to apply in the mapping process (Andrew et al., 2015; Bagstad et al., 2013).

Benefit transfer is the process of identifying ecosystem valuation data from primary research (conducted at the primary “study” site), and *transferring* the identified value to a secondary or “policy” site (Plummer, 2009). Plummer (2009) explains that the term “policy” site refers to the fact that this information is often applied in a policy setting. Benefit transfer uses land cover as a proxy for ecosystem services (making the assumption that certain types of land cover provide a specific suite of ecosystem services) and applies a value estimate per acre to all areas with the same LULC. It is essential to ensure a close match between the study and policy sites, in terms of ecology, geography, demographics, and socioeconomics, to prevent a lack of correspondence, a potential source of error when applying this method (Plummer, 2009). According to Rosenberger and Phipps (2007), ensuring a strong correspondence is essential to the accuracy of benefit transfer.

Benefit transfer methodology has become an increasingly important tool for government agencies, consultants, scientists and others over the past 10 years. The U.S. Geological Survey provides a Benefit Transfer Toolkit on its website (USGS, 2018), available for use in making land and natural resource decisions. The toolkit is a compilation of value estimates on ecosystem services that are not traded in conventional markets. Spatially explicit value transfer methods have been applied to valuation of ecosystem services around the globe, including studies of the State of Maine (Troy 2012) and nearby areas such as the State of New Hampshire (Trust for Public Land, 2014) and the greater Montreal area of Canada (Dupras et al., 2015).

Three publicly-available, national valuation databases were queried to acquire proxy values by land cover type and ecosystem service. These were the Environmental Valuation Research Inventory (EVRI), Oregon State (OSU) Recreation Database, and the USGS Benefit Transfer Toolkit. Primary studies identified through these databases were reviewed to locate valuation data from similar geographic and socioeconomic study sites for transfer to the policy site. Primary studies were selected for value transfer based on similar regions in New England, Canada and Minnesota; primary studies that did not match essential characteristics of the policy site were excluded. These original valuation studies included various economic analysis methodologies, such as contingent pricing, travel-cost method, and hedonic pricing.

Using results from the databases that most closely matched the policy site, an average value was obtained for each ecosystem service provided by the land cover classifications in the study area. Once a suitable study was identified, a unit value was derived for each ecosystem service, providing an annual dollar estimate on a per-unit basis (e.g. per acre, per resident household, per licensed angler/season). A constant dollar value was then multiplied by the number of units at the policy site. For those transfer values presented on a per acre basis, the land cover area was multiplied by the per acre proxy value. Land cover types then received a total dollar value for the ecosystem services provided across the study area. All values were converted to 2017 dollars.

Example: Open Water, Recreational Fishing
WTP as determined by stated preference methods = $589.67/angler/season (2017 $US)
Number licensed anglers in Downeast Maine in 2016 = 22,405
$589.67 x 22,405 = $13,211,556.35

2.4 Market Analysis

Certain ecosystem services are traded in the marketplace, and can be measured directly by monitoring market data (market analysis.) Market-based assessment is commonly applied to provisioning services, and this study measured the economic contributions of wild blueberries and timber in this way. Similarly, measuring carbon sequestration, a service that provides benefits on a global scale therefore "equalizing" the value across all sites (Plummer, 2009), can use market-based data for valuation as market prices exist for this service.

2.4.1 Wild Blueberries

Vaccinium angustifolium, commonly known as the wild lowbush blueberry, is the state fruit of Maine and an important commercial crop in the Downeast region. The University of Maine Cooperative Extension reports that Maine is the most significant producer of blueberries in North America, wild or cultivated, at 10% of total production (Yarborough, 2015). Most of this intensive blueberry production in the state is concentrated in the Downeast region where 99% of wild blueberries harvested are frozen for future sale (Yarborough, 2015). Lowbush blueberries benefit the Downeast economy, provide many human health benefits, and also serve as a popular, seasonal food source for a range of wildlife.

To calculate the value of wild blueberries on Downeast conservation lands, the USDA National Agricultural Statistics Service was referenced to determine the average yield and average price of wild blueberries in Maine for 2016. The following formula was then applied to calculate the Total Annual Value, TAV:

Price, \$/lb * Yield, lb/acre * Acres of blueberries on conserved land = TAV, \$.

2.4.2 Timber Harvest

Calculation of the value of timber harvest on Downeast conserved land was performed by applying publicly available data from the U.S. Forest Service Forest Inventory and Analysis (FIA). Volume per acre from the FIA was used to assess change over 5 years in total biomass stock, measured in dry metric tons. It was assumed that the reductions in stock over the time period were due to harvests, and that the harvested amount was evenly split between pulpwood and sawlogs, as well as across all species types reported in the Maine Stumpage Report for Washington and Hancock County. The value obtained was divided by five to calculate an annual harvest value.

County stumpage prices for 2016 were then applied (State of Maine, 2017). Stumpage prices were originally reported in MBF (a unit of measurement equal to 1000 board feet) and imperial green tons, then subsequently converted to dry metric tons. Harvest wood value per dry ton was then calculated. An estimated dollar value/acre/year for timber 'provision' from forests on Downeast conservation land was then determined from this process, and applied toward the annual harvest revenue for the area.

These figures may overestimate the value of timber harvest on conserved lands in the study area. For the purposes of this study, we were not able to determine the percent of acres actually harvested over the most recent time period. In addition, due to the sensitive nature of FIA information, exact plot locations are not disclosed. Therefore this represents an estimate of biomass change on Downeast conserved lands. However, many conservation lands in the region do actively harvest, so the assumption that biomass loss is due to harvest activity is not unreasonable. The Maine Land Trust Network (MLTN, 2017) reports that more than 85% of the total acreage held by private land trusts in the state is in working forestlands; these lands are not restricted from harvest as a condition of the conservation easement, and many land trusts do harvest to further conservation goals.

One of the largest parcels of conserved land in the study area is the 55,578 acre Downeast Lakes Community Forest, which is owned and stewarded by Downeast Lakes Land Trust (DLLT). DLLT manages the Community Forest for timber harvest and wildlife habitat. Permits are issued to local users of forest products for gravel, firewood, gathering of branch "tips" for wreath-making, and craft wood (DLLT, 2016). A Public Access Policy for the Community Forest allows for "traditional recreational uses to include fishing, hunting, trapping, guiding, camping, picnicking, swimming, boating, snowmobiling, ATV-ing, snowshoeing, cross-country skiing, dog sledding, hiking, nature observation, and enjoyment of open space." (DLLT, 2010). Downeast Lakes Community Forest offers multiple benefits to the region, and provides roughly 170 jobs in the forest industry sector. (Downeast Lakes Land Trust, 2018b)

2.4.3 Climate Regulation through Carbon Sequestration

Forests are important to the global carbon cycle, as forest ecosystems can serve as carbon sinks. Carbon dioxide is removed from the atmosphere through photosynthesis and the carbon is sequestered in woody biomass, plants, and soil, thereby reducing atmospheric carbon and offsetting fossil fuel emissions (Pacala et al., 2001; Ciais et al., 2008; Coomes et al., 2012; Binder et al., 2017). The value of carbon is a new market, with active carbon markets providing a dollar value for each ton of carbon sequestered in forests. The benefits of carbon sequestration are measured by assigning a dollar value for each ton of carbon removed from the atmosphere. This value is typically expressed through prices faced in current carbon offset market sales

(Binder et al., 2017), or prices derived from model-based analyses (e.g., Sohngen & Mendelsohn, 2003). This study used national-level figures to estimate by the U.S. government to assign monetary values to potential carbon sequestered on conserved lands in Downeast Maine forests.

The social cost of carbon (dioxide emissions), or SCC, measures the damage costs of climate change. SCC is the marginal damage cost from 1 ton of carbon emitted into the atmosphere (Tol, 2011). Binder et al. (2017) explain that this amount of carbon, which would have been emitted but instead does not enter the atmosphere, is complicated by impermanence, or that carbon stored in trees or other biomass eventually is either harvested or decomposes. They provide the example of timber rotation processes increasing carbon storage, which is subsequently emitted post-harvest.

Our study accounts for this impermanence by applying Sohngen and Mendelsohn's approach (2003) for calculating a carbon "rental value," which is equal to the interest earned from selling one ton of stored carbon at the current price (\$36 per ton of CO_2), less any capital gains from changes in that price. Carbon stock, the average biomass per acre, was estimated using standing volume estimates derived from FIA data. Total biomass estimates were used to derive annual carbon stock, measured in metric tons carbon of dioxide equivalent (tCO2-e). A rental value, equivalent to the SCC value (*x*), was then directly applied to the carbon stock. It was assumed that the rental value is equal to the discount rate used for the SCC estimate, or 3%. Thus, the calculation for the value of forest carbon on a given forest area is:

Annual Forest Carbon Value = \$x/tCO2-e * 3% * Carbon Stock.

2.5 Tourism - Visitor Spending Effects

A number of factors contribute to regional economies, including exports from the region, import substitution, capital investment, and innovation; however, for small regions (e.g.

counties), exports that bring money into the area are considered the major drivers of the local economy (Watson et al., 2015). Tourism is an export industry that is vital to this study region. Visitors to state and national parks and other conserved lands in Downeast Maine spend a significant amount of money and time in the surrounding gateway communities. Towns such as Ellsworth, Eastport, Bar Harbor, and others depend on the economic activity generated by the visitors drawn to Acadia National Park, Petit Manan National Wildlife Refuge, Quoddy Head State Park, and conserved properties held by private land conservation organizations.

Koontz et al. (2017) define visitor spending effects (VSE) as the direct and ripple effects of visitors' spending money on employment and business activity in gateway economies surrounding parks. The National Park Service measures and reports the economic contributions of national park visitor spending by multiplying total visitor spending (i.e. residents and non-residents) by regional economic multipliers. Results reflect the scope and magnitude of economic activity generated by visitor spending for the surrounding local economies, which the NPS defines as being within a 60-mile radius of the NPS unit being assessed (Cullinane et al., 2018).

Research suggests that public and protected lands vary in their contributions to local economies based on their designation or type. Several authors have identified an increase in visitation seen when changing a national monument designation to a national park (Weiler & Seidl, 2004; Weiler, 2006; Rasker, 2018), although Rasker points out that there was "no clear distinct designation effect such as immediately increased visits after re-designation" (p.27). Cline et al. (2011) provide a methodology for characterizing different economic contributions to regional economies based on their type of designation as a protected area. Their framework applies two characteristics, quality of the unit and quantity of visitation, to evaluate the effect of varying protected land types on their surrounding economies. Higher quality sites (as determined by their level of protection) are expected to attract more visitors, based on their “signaling” of a higher quality experience. The authors then present a typology and hypothetical gradient of protected area status.

To estimate visitor spending effects of conserved lands in the Downeast region, an adaptation of Cline et al.’s (2011) methodology was applied; raw data was not available to be able to calculate VSE for each property (see Figure 2.1). VSE data for Acadia National Park and St. Croix Island International Historic Site were obtained from the National Park Service for 2017 (Cullinane et al., 2018), and represent the top two tiers of potential visitor quality. Values for the remaining conserved lands were extrapolated and scaled down by 30% each per designation (derived from the percentage difference between the available data from Acadia and St. Croix Island). Each designation is based on visitor willingness to pay (WTP) for the respective site quality. National parks have the highest perceived quality and therefore hold the highest value per visitor, with privately conserved, inland properties holding the lowest value per visitor. As Cline et al. (2011) point out, this graph essentially reflects the supply curve as represented by visitors to the conserved lands in terms of dollar value per visitor.

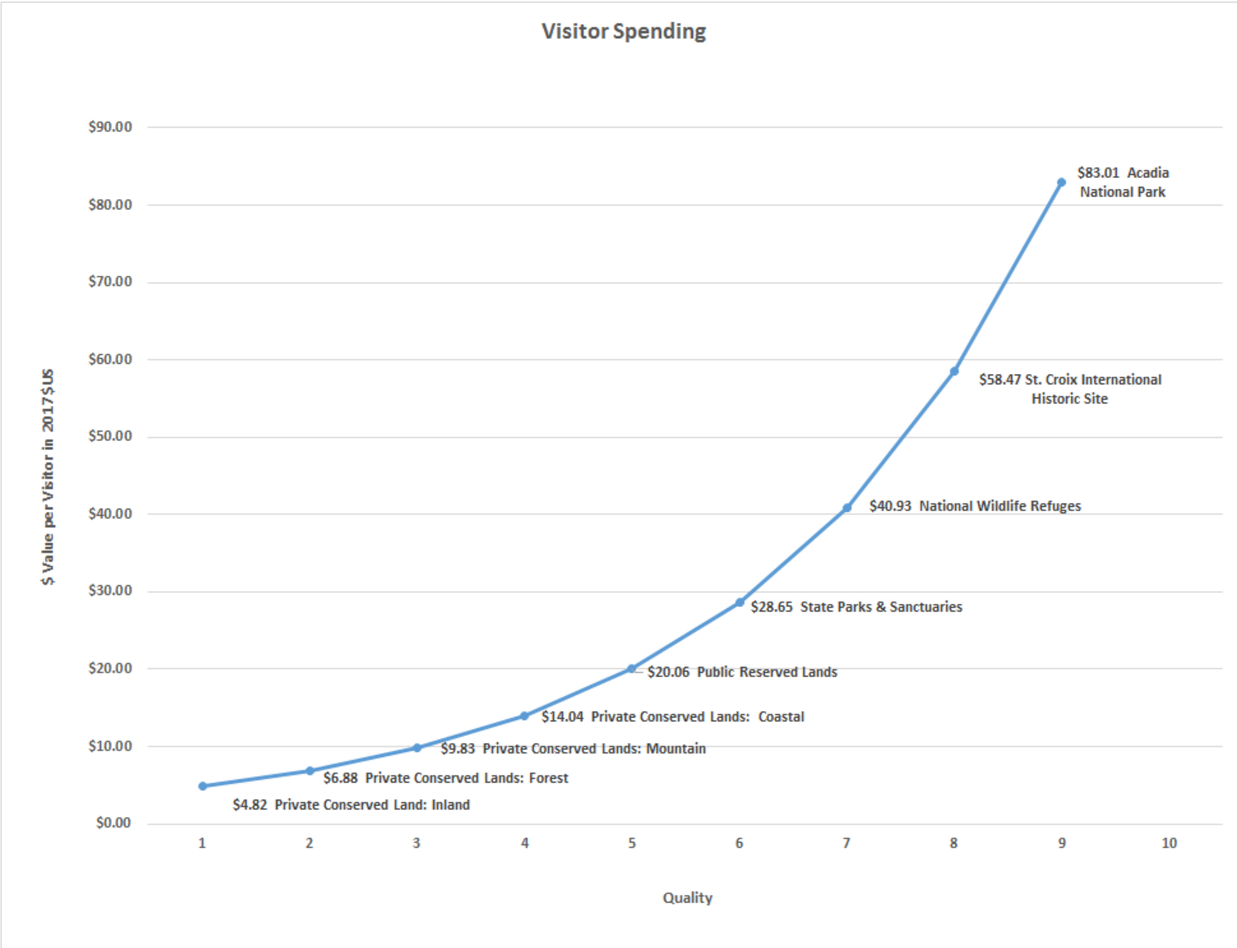


Figure 2.1. Est. Continuum of Conserved Land Status

To calculate total annual visitor spending effects, and subtotals from each conserved land type, the dollar value per visitor was then multiplied by the number of annual visitors to each of the conserved land types, where visitation data was available. Because many conserved lands offer open access to the public, visitor numbers are not tracked. Where this data was unavailable, expert elicitation was applied.

Example: Moosehorn National Wildlife Refuge

54,920 visitors in 2017; Visitor spending = $40.93/visitor for national wildlife refuges

54,920 x $40.93 = $2,247,875 total annual visitor spending effects from this refuge

2.6 Employment: Understanding the Role of "Green" Jobs

The relationship between conservation and employment has been a controversial one for many years, with various business interests and others expressing concern over job losses (particularly in extractive industries, such as timber production) when land is put in conservation (Hudnor, 2007; Bezdek et al., 2008; BenDor et al., 2015). It is necessary to conduct an accounting of the employment that is generated by environmental conservation to better understand any re-sorting of jobs (Aronson et al., 2010; Bezdek et al., 2008; BenDor et al., 2015; Chen et al., 2016; Samonte & Ramanzoni, 2017). The links between ecological restoration projects and economic development are often overlooked in the literature (Aronson et al., 2010; BenDor et al., 2015). BenDor et al. (2015) define the economic output and employment generated by environmental conservation, mitigation, and restoration as components of the "restoration economy." They point out that the restoration economy provides an employment ripple effect, providing jobs not only in direct conservation work, but also opportunities for landscape architects, legal and planning professionals, government employees, plant nurseries, earth movers and construction workers, and individuals working in mitigation banking or the carbon market.

Lewis et al. (2002) created an econometric model to analyze the impact of public conservation lands on employment rates in the Northern Forest region, which includes this project's study area. They quantified the effect of public conservation lands on employment growth, as well as the impact conserved lands have on net migration. Results showed that a use change from timber production to the establishment of new conservation lands did not have an impact on employment over the range sampled in their study. Their model also showed that both net migration growth and employment were positively (and significantly) affected by the presence of state and national forests. Although they reported that, during the 1990s, conservation did not negatively impact employment, they also found no evidence to suggest that conservation promoted rural job growth. However, Hudnor (2007) found a positive, significant relationship between all categories of conservation lands in her study and employment in the tourism sector of US counties, based on data collected by the National Outdoor Recreation Supply Information System (NORSIS) and compiled in 1997 by the US Forest Service.

The relationship between conservation land and regional employment is thus difficult to predict. Estimating the indirect employment effects of conserved lands or the relationship between conservation, migration, and employment was outside the scope of this study, but an attempt was made to capture direct employment in the conservation industry through quantifying industry-related jobs and related salaries and benefits paid to individuals working directly in conservation in the Downeast Maine region. The estimate is conservative, as it includes only those individuals directly employed by the entities who hold lands in conservation. It does not include the indirect effect of additional jobs generated outside of these organizations, such as in associated recreational employment (sporting outfits, guides, etc.), or jobs in the "restoration economy" which include a variety of industries that participate in environmental conservation, mitigation, and restoration.

Employment and salary information for local land trusts in the Downeast region were obtained by searching Guidestar.org for organizational I-990 tax return documents. For state and federally protected properties, this information was provided by personal communication with various agencies. Estimates for employment within the region by statewide and national conservation organizations were included where available. Since a significant proportion of this data could not be obtained, these values are conservative and represent the lower bound limits of actual employment and wage totals.

The overall value of conservation lands was deduced by applying a range of methodologies, some involving WTP and WTA, and others directly measured in the marketplace, so the economic contribution is an estimate. This is likely a lower-bound estimate based on a select group of ecosystem services, visitor spending effects, and employment, and does not represent the total economic value of these conserved lands. The lower-bound nature of the estimate arises from several sources. First, many lands held in conservation are open-access to the public, and visitor numbers are not tracked, so VSE estimates are likely too low. Many conservation organization wages and salaries could not be obtained, so the employment effects are also probably low. The ecosystem services considered were a subset of all ecosystem services that provide benefits to humans; for the ones considered, data was compiled from a wide range of local, state, national, and federal resources. In some instances, data was incomplete or missing. In the following summaries, items are classified as “unknown” where this occurred. For all results, slight errors and rounding may result in totals not equal to 100%.

CHAPTER 3 RESULTS

A total of 702,654 acres has been conserved in the Downeast Maine region, as of June 2017. Of the total land in the two-county area, 19.6% is held in some type of conservation status as defined by this study. Hancock County has 12.5% of its area in conserved land (1,500,800 acres), while Washington County has double that at 25% (2,085,120 acres). The majority of these Downeast conserved lands are forestland (72.4% or 508,498 acres).

Table 3.1. Conservation land by county

	Total area (acres)	**Acres held in conservation**	**% of County**
Hancock	1,500,800	187,002	12.5%
Washington	2,085,120	515,653	25%
Total	**3,585,920**	**702,654**	**19.6%**

There is an approximate 60/40 ratio between lands held under conservation easements and those purchased through fee simple acquisition. A very small percentage of lands (about one-half of one percent) were held in some other type of arrangement, including deed restrictions, leases, management transfer agreements, or restricted areas. In a few cases, the type was not indicated, and these were listed as unknown.

Conserved lands are owned by a variety of entities, including government (municipal, state and federal), private (land trusts, other conservation organizations), or of unknown ownership. There is also an approximate 60/40 ratio between public and private ownership of conservation lands in the region. A detailed list of landowners and public units of conservation lands, along with socio-economic data for the two counties, is included in the Appendices.

Table 3.2. Conserved land area by conservation and ownership types

Conservation Type	**Total Acres**	**% by Type**	**Washington County**	**Hancock County**
Fee simple acquisition	298,182	42.44	151,865	146,317
Conservation easement	400,919	57.06	360,779	40,141
Unknown/Other (Deed restriction, Lease Management transfer agreement, Restricted)	3,552.73	<1	3,009	544
Total	**702,654**	**100**	**515,613**	**187,002**
Ownership Type	**Total Acres**	**% by Type**	**Washington County**	**Hancock County**
Public	281,888	40.12	145,756	136,132
Private	420,653	59.86	369,851	50,802
Unknown	113	<1	45	68
Total	**702,654**	**100**	**515,652**	**187,002**

The majority of Downeast conserved lands are forestland (72.4%). The breakdown of conservation lands by land use/land cover status is detailed in Table 3.3. Acres may not sum to precisely 100% due to rounding. A map of land cover class for conserved lands follows (Hancock County in Figure 3.1 and Washington County in Figure 3.2). Figures 3.3 and 3.4 display conserved lands by ownership type for Hancock County and Washington County, respectively. The next two maps show conservation lands by conservation type for Hancock (Figure 3.5) and Washington (Figure 3.6) Counties.

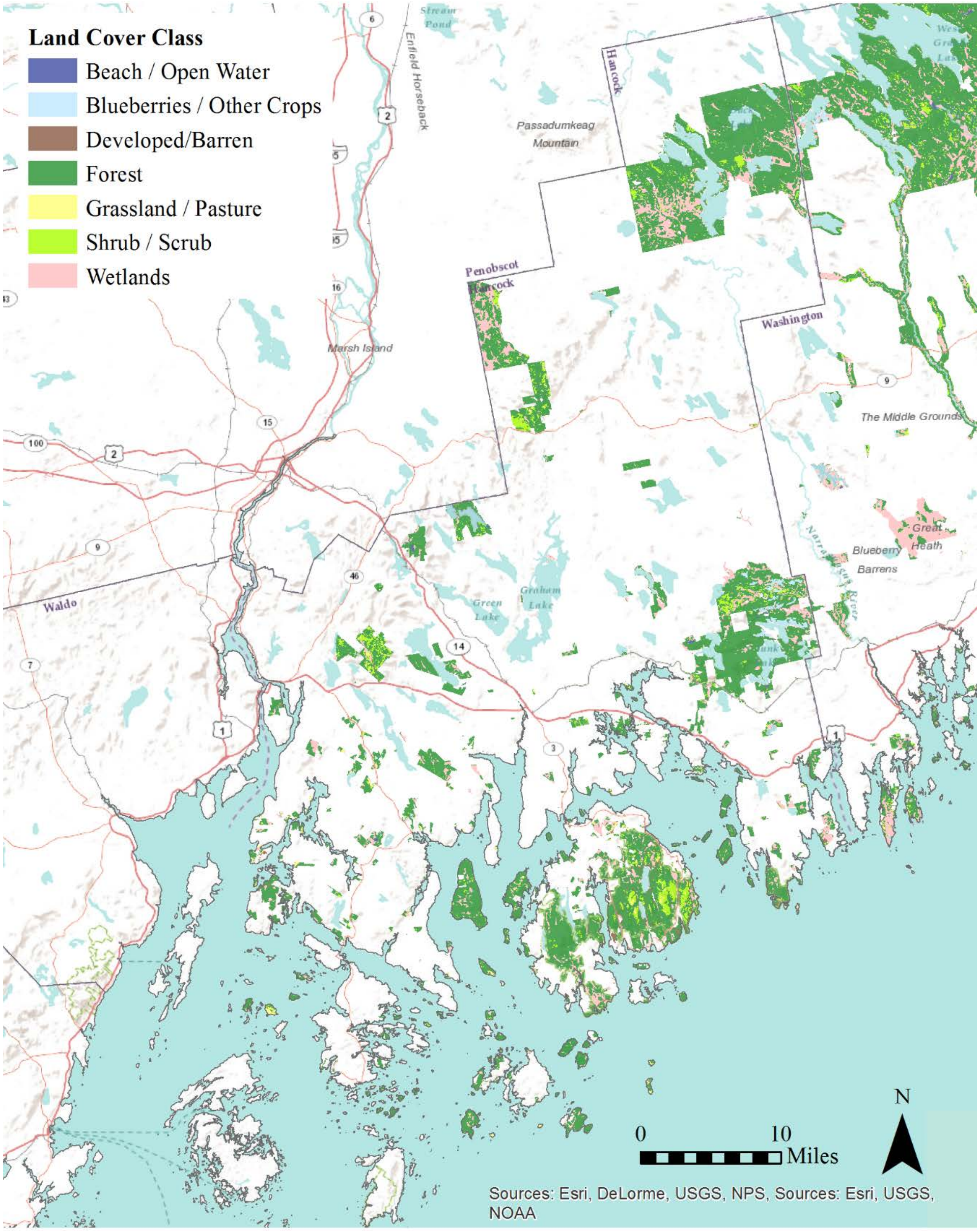
Table 3.3. Conservation land by land use/land cover type

Land Cover Classification	# Acres Conserved	% Conserved Area	Washington County	Hancock County
Barren Land (Rock, Sand, Clay)	1,860	0.26%	940	920
Beach (sandy)	30	<1%	17.5	12.5
Blueberry Barrens >40 acres	3,594	0.51%	1,731	1,864
Cultivated Crops	579	0.08%	305	275
Developed	7,708	1.1%	4,233	3,475
Forest[1]	508,498	72.4%	371,225	137,243
Grassland / herbaceous	6,972	0.99%	4,358	2,614
Open Water	10,000	1.42%	6,205	3,795
Pasture / Hay	986	0.14%	430	556
Shrub/Scrub	32,684	4.65%	23,260	9,424
Wetlands[2]	129,743	18.47%	102,918	26,825
TOTAL	**702,654**			

[1] Forestland includes deciduous forests, 80,205 acres; evergreen or conifer forests, 210,437 acres; and mixed woods, 217,857 acres. By county these totals are: 60,987 acres deciduous, 133,906 acres evergreen, and 176,362 acres mixed for Washington County and 19,218 acres deciduous, 76,531 acres evergreen, and 41,494 acres mixed wood for Hancock County.

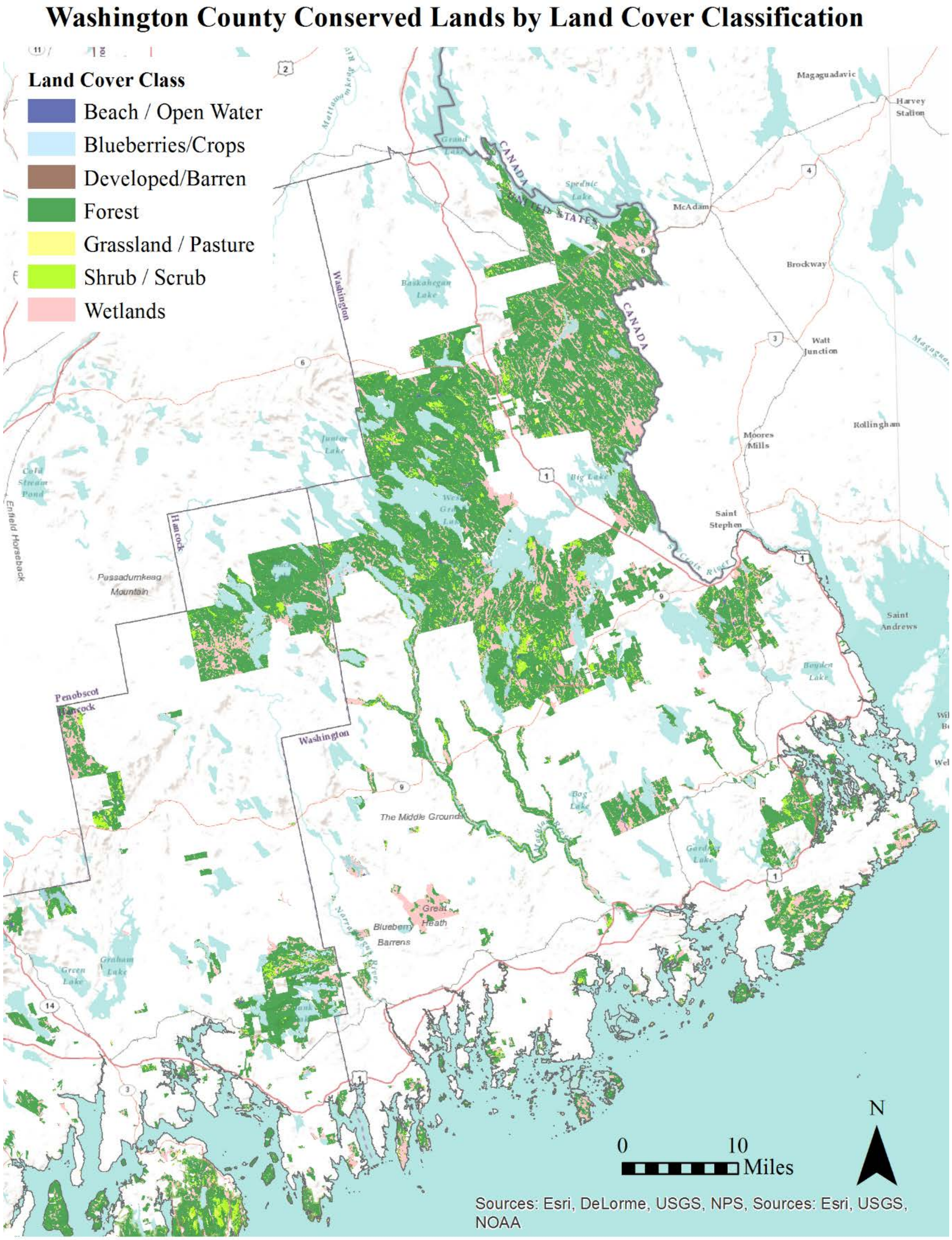
[2] Wetlands include both emergent herbaceous (19,771 acres) and woody (109,972 acres).

Hancock County Conserved Lands by Land Cover Classification



Sources: Conserved lands data from MEGIS and regional conservation organizations. Land cover data from NLCD 2011.

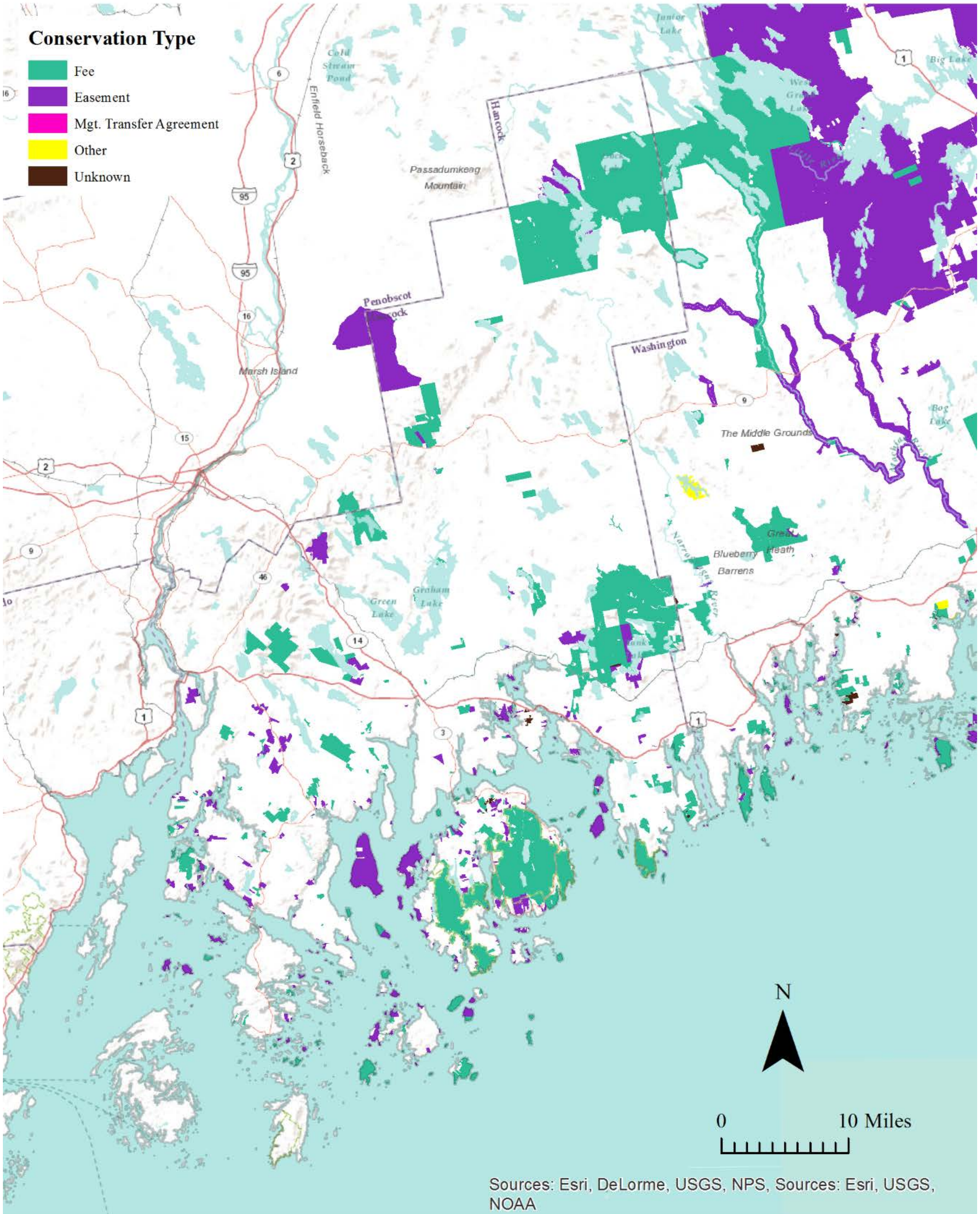
Figure 3.1. Hancock County conserved lands by land cover classification



Sources: Conserved lands data from MEGIS and regional conservation organizations. Land cover data from NLCD 2011.

Figure 3.2. Washington County conserved lands by land cover classification

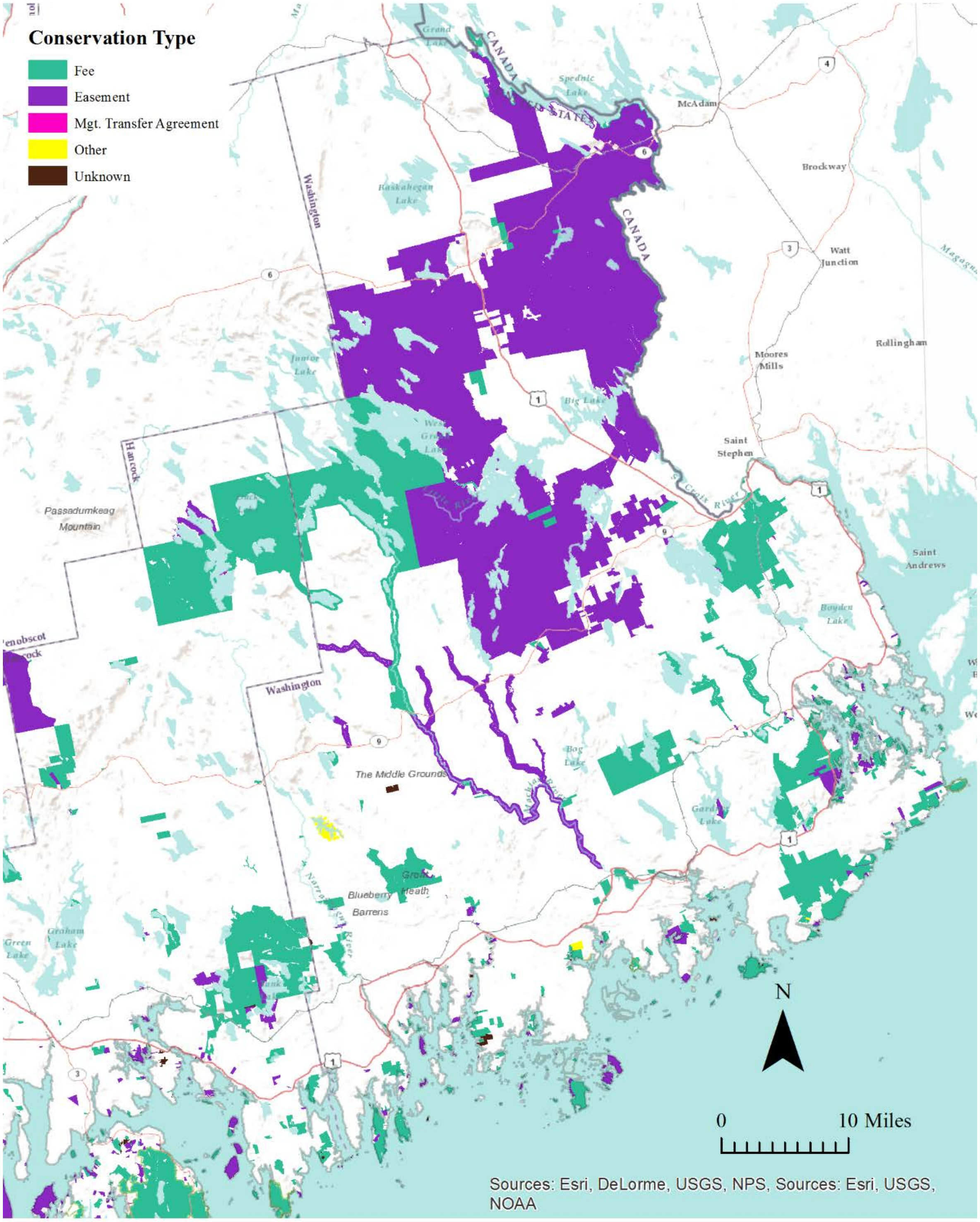
Hancock County Conserved Lands by Conservation Type



Sources: Conserved lands data from MEGIS and regional conservation organizations; Land use/land cover from NLCD 2011.

Figure 3.3. Hancock County conserved lands by conservation type

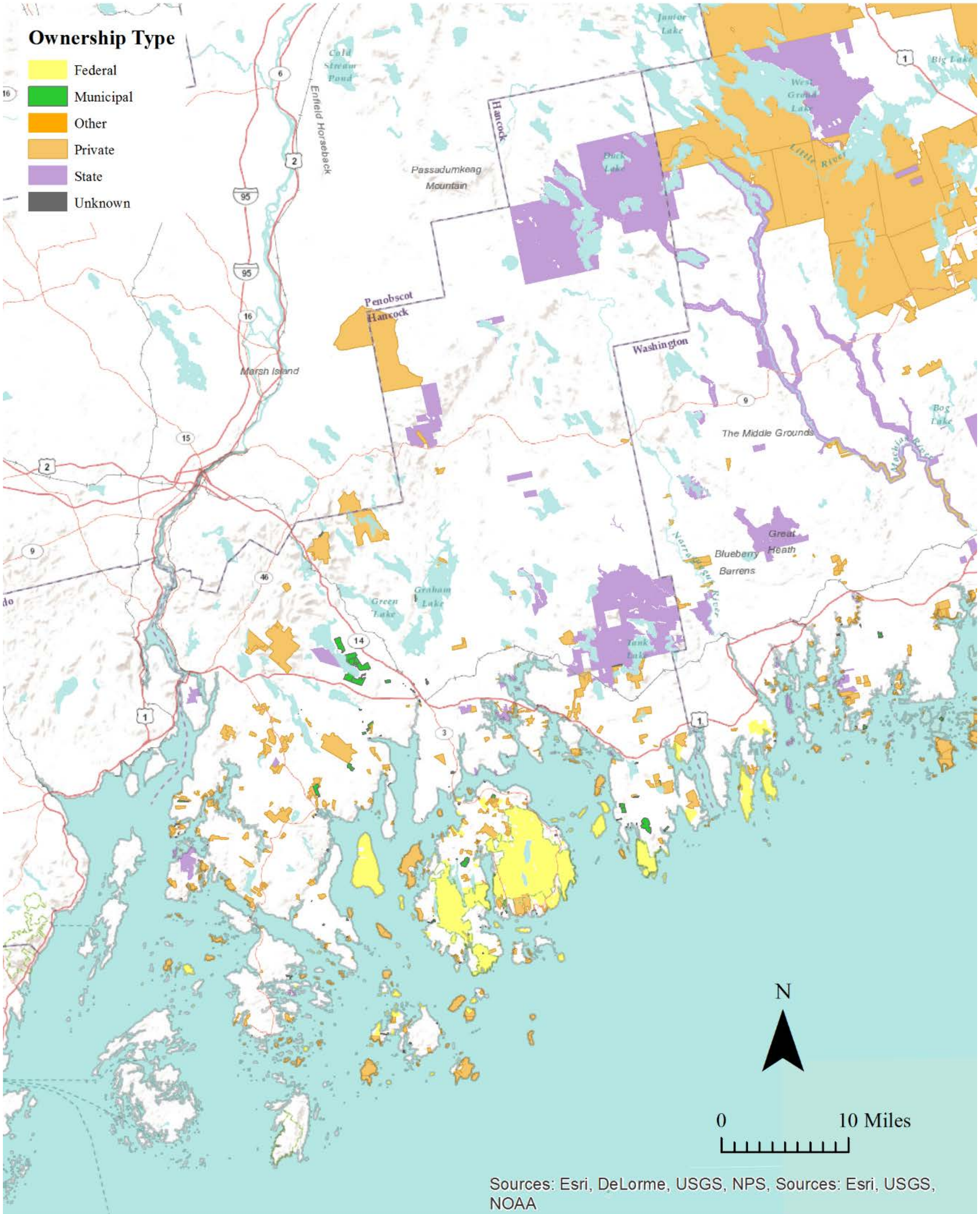
Washington County Conserved Lands by Conservation Type



Sources: Conserved lands data from MEGIS and regional conservation organizations; Land use/land cover from NLCD 2011.

Figure 3.4. Washington County conserved lands by conservation type

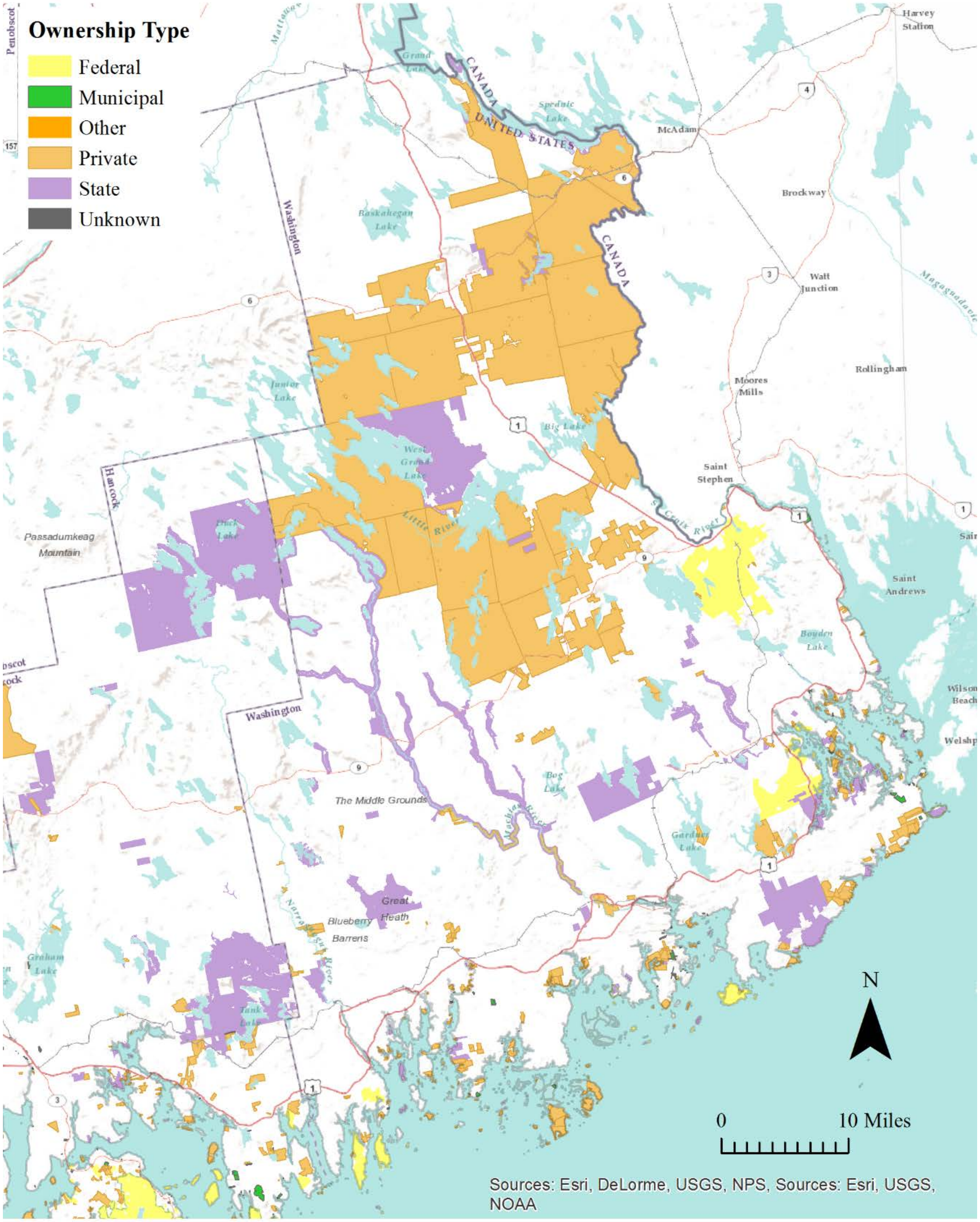
Hancock County Conserved Lands by Ownership Type



Sources: Conserved lands data from MEGIS and regional conservation organizations; Land use/land cover from NLCD 2011.

Figure 3.5. Hancock County conserved lands by ownership type

Washington County Conserved Lands by Ownership Type



Sources: Conserved lands data from MEGIS and regional conservation organizations; Land use/land cover from NLCD 2011.

Figure 3.6. Washington County conserved lands by ownership type

3.1 Value of Conserved Lands

3.1.1 Market Ecosystem Services: Blueberries, Timber and Carbon

In 2016, the yield per acre for wild blueberries in Maine was 4,400 lbs, and the average price was $0.27/lb. Assigning these averages to the total acreage of blueberry fields identified on conserved lands Downeast, adjusted for 2017 dollars, yielded a total value of $4,441,694.

U.S. Forest Service Forest Inventory and Analysis (FIA) data was used to calculate change in standing biomass over a five-year period. It was assumed that the reductions in stock were due to harvests, and that the harvested amount was evenly split between pulpwood and sawlogs, as well as across all species types reported in the Maine Stumpage Report for Washington and Hancock County. The value obtained was divided by five to calculate an annual harvest value of $28/acre/year from forests on Downeast conservation land. This translates to about $17.5 million annually in harvest revenue for the area. These figures may be overestimates; they are based on interpolating volumes from FIA plots that represent a large area on the ground.

Applying Sohngen and Mendelsohn's approach (2003) for calculating a carbon "rental value," (which accounts for the impermanence of carbon stored in forests), the average forest carbon value in the region was calculated to be $80/acre/year for a total annual value across all forestland of over $42 million. Given the coarse nature of the FIA input data used in both timber harvest and carbon value calculations, only a two-county summary value was calculated.

Case Study: Downeast lakes Land Trust (DLLT) Carbon Offset Projects

In 2010, DLLT began participation in the carbon market by entering into a partnership with Finite Carbon Corporation, a forest carbon development company that creates and monetizes carbon offsets. Working under an improved forest management framework, DLLT registered the 19,118-acre Farm Cove Forest Carbon project with the Climate Action Reserve (CAR), and in 2013 was issued nearly 200,000 compliance-eligible carbon offset credits. These credits were sold in the California compliance market, resulting in more than $2M in income that allowed for the creation of the Downeast lakes Community Forest.

In 2013, DLLT worked with Finite Carbon Corporation and the Lyme Timber Company on a second improved forest management project on 22,000 acres in Grand Lake Stream Plantation. Known as the West Grand Lake Project, it was listed with the California Air Resources Board, and sequestered an additional 599,217 metric tons of carbon dioxide equivalent (CO_2e) emissions, the credits for which were sold in 2016 to a California Compliance Buyer. Funds were used by DLLT to purchase the 22,000 acre property from Lyme Timber, which ultimately became a part of the 55,678 acre Downeast Lakes Community Forest (Downeast Lakes Land Turst, 2018a).

3.1.2 Visitor Spending

Visitor spending effects for the study area totaled $304,427,779 in 2017 (Table 3.4). This is a conservative estimate, as private conserved lands, and many state public lands are free and open-access, and do not track visitor numbers; therefore a true value of visitor spending provided by private conserved lands could not be calculated. Acadia National Park represents the majority (96%) of these measured spending effects at $291,304,586 in 2017. Total visitor spending effects for conserved lands outside of Acadia was calculated as $13,123,192 for 2017. Expert elicitation was used to determine approximate number of visitors where data was lacking. It is of note that all the underestimation is for properties other than Acadia National Park; there, actual visitors are tracked. In all, Hancock County visitor spending effects are estimated at $296,963,195 and

Washington County at $7,464,585; some lands appear in both counties and so are not broken out by county.

Table 3.4. Visitor spending estimates

Location	**2017 Visitors**	**VS ($2017)**	**Total**	**County**
Acadia National Park	3,509,271	$83.01	$291,304,586	Hancock
St. Croix Island International Historic Site	13,856*	$61.83**	$856,716	Washington
Moosehorn National Wildlife Refuge	54,920	$40.93	$2,247,876	Washington
Cross Island National Wildlife Refuge	1,100	$40.93	$45,023	Washington
Petit Manan National Wildlife Refuge	84,300	$40.93	$3,450,399	Hancock
Holbrook Island Sanctuary	10,237	$28.65	$293,290	Hancock
Lamoine State Park	52,224	$28.65	$1,496,218	Hancock
Quoddy Head State Park	102,435	$28.65	$2,934,763	Washington
Roque Bluffs State Park	23,013	$28.65	$659,322	Washington
Cobscook Bay State Park	14,861	$28.65	$425,768	Washington
Shackford Head State Park	~ 500	$28.65	$14,325	Washington
Ft. O'Brien State Historic Site	~ 500	$24.54	$12,270	Washington
Donnell Pond Public Reserved Land	~ 10,000	$20.06	$200,600	Hancock
Duck Lake Public Reserved Land	~ 500	$20.06	$10,300	Hancock
Cutler Coast Public Reserved Land	~ 1,000	$20.06	$20,060	Washington
Great Heath Public Reserved Land	~ 500	$20.06	$10,300	Washington
Machias River Corridor	~ 500	$20.06	$10,300	Washington
Rocky Lake Public Reserved Area	~ 1,000	$20.06	$20,600	Washington
Downeast Sunrise Trail	~ 10,000	$20.06	$20,600	both
Private Conserved Lands: Coastal	~ 10,000	$14.04	$14.04	both
Private Conserved Lands: Mountain	~ 100	$9.83	$9.83	both
Private Conserved Lands: Forest	~ 10,000	$6.88	$6.88	both
Private Conserved Lands: Other Inland	~ 1,000	$4.82	$4.82	both
TOTAL			**$304,427,779**	

* 2016 ** Converted from 2016 value of $58.47

3.1.3 Direct Employment

Estimating the direct conservation industry employment was a priority for stakeholders in this study. The most currently available data was applied (which varied between organizations), and represents 2015, 2016, and 2017. All dollar values were then converted to 2017 $USD using the consumer price index.

Organizations that hold land in conservation in Downeast Maine employed a minimum of 440 individuals, representing $13,903,184 in salaries, other compensation, and employee benefits. This is a lower-bound estimate which was limited by data availability. These employers include land trusts and conservation organizations which operate at local, regional, state, or national levels (e.g. the staff at Downeast Lakes Land Trust). Government employees at the municipal, state, and federal levels are also included where information was available, such as the Park Manager and Rangers at Lamoine State Park. The bulk of this employment is generated by Acadia National Park which employed 278 of the 440 individuals (63%) in 2017 representing wages and fringe benefits totaling $10,623,969.

3.1.4 Non-market Ecosystem Services

Initial stakeholder ecosystem services of interest were compared against available studies that met the criteria for appropriateness for benefits transfer. Ecosystem services, the land cover they are represented by, and input values used in the calculations are detailed in Table 3.5. Units represent the unit of analysis of the primary study. For example, some benefits are calculated as accruing to the users (e.g., hunters), while some to the area residents (people or households). Some are calculated per unit of land (acre). Acadia National Park was included to capture the benefits that it provides to local residents, as opposed to visitors, who were captured in the visitor spending effects calculation.

Table 3.5. Land cover, associated ecosystem services, and benefits transfer values

Ecosystem Service	Unit (annual)	Value/unit (2017$)
Land Cover type: Open Water		
Recreation - access to area with migratory fish	Resident household	$31.07
Recreational fishing: fresh & salt	Angler	$589.67
Recreation - non-motorized boating	User	$49.49
Recreation - water quality	User	$279.03
Wildlife Habitat - migratory fish spawning habitat	Household	$0.89
Land Cover Type: Forests		
Carbon sequestration	Ton of CO_2	$36
Recreation - camping	Users	$14.82
Recreation - deer hunting	Acre	$46.04
Recreation - moose hunting	Hunter	$1,301.21
Recreation - black bear hunting	Hunter	481.88
Timber production	Acre	$28
Water supply	Acre	$26.82
Land Cover Types: Scrub/Shrub, Grassland/Herbaceous, Pasture/Hay, Cultivated Crops		
Carbon sequestration	Ton of CO_2	$36
Recreation – deer hunting	Acre	$46.04
Wild blueberry production	$/acre	$1,188
Land Cover Type: Wetlands		
Carbon sequestration	Ton of CO_2	$36
Clean water	Resident	$130.69
Recreation – deer hunting	Acre	$46.04
Land Cover Type: Beaches		
Recreation – access	User	$5.09
Special Land Cover: Acadia National Park		
Recreation access	Resident household	$135.30
Science and educational value	Resident household	$133.02

Beaches were not a separate category in the LULC classification and are not common throughout the study region. However, they represent a unique recreational opportunity, and one that is valued and provided on conservation lands. To calculate the benefit of beaches on conserved lands, public beaches were identified and mapped using local knowledge and Google Earth. Visitation was estimated for each using expert elicitation. Thirteen beaches were identified on conserved lands in the study region (Table 3.6).

Table 3.6. Beaches used in valuation calculation

Beach	**Est. # Visitors**	**Value**	**County**
Lamoine State Park	52,000	$264,680	Hancock
Town of Lamoine	3,600	$18,324	Hancock
Sand Beach, Acadia National Park	100,000	$509,000	Hancock
Roque Bluffs State Park Beach	23,000	$117,070	Washington
Jasper Beach, Machiasport	3,600	$18,324	Washington
Jones Beach, Lubec	3,600	$18,324	Washington
Marlboro Beach, Lamoine	3,600	$18,324	Hancock
Seal Harbor Beach, Mt Desert	3,600	$18,324	Hancock
Causeway Beach, Deer Isle	3,600	$18,324	Hancock
Reach Beach, Deer Isle	3,600	$18,324	Hancock
Sand Beach, Swan's Island	1,000	$5,090	Hancock
Star Beach, Swan's Island	1,000	$5,090	Hancock
Joyce Beach, Swan's Island	1,000	$5,090	Hancock
Total		**$1,034,288**	

A summary of the values associated with non-market ecosystem services on conservation lands in the Downeast region is provided in Table 3.7.

Table 3.7. Summary of non-market ecosystem service values on conserved lands

ECOSYSTEM SERVICE	VALUE (2017 $USD/yr)	Hancock County	Washington County
Recreation, all types	$57,852,801	$39,873,910	$17,978,905
Science and Education	$5,029,885	$3,158,959	$1,870,926
Beach Access	$1,034,288	$880,570	$153,718
Clean water (water purification)	$11,292,662	$7,120,383	$4,172,278
Water supply (water provisioning)	$5,519,072	$4,029,482	$1,489,591
Wildlife Habitat provision	$33,654	$21,136	$12,518

3.2 Summary of Results

Our analysis attempted to calculate as many of the known values that conservation lands provide to the Downeast region as possible, using a methodology that is backed by research. Our analysis is conservative in that only the most appropriate studies were selected for the benefits transfer and when lacking input values, lower bound estimates were used. In addition, we did not incorporate the indirect or induced effects of market-based values as is commonly done. These represent only direct values. Overall, direct market values were used for blueberries, timber, and carbon values on conservation lands; indirect market values for visitor spending effects; and non-market valuation (benefits transfer) used for recreation, science and education, beach access, clean water, water supply, and wildlife habitat provision. In addition, we included the direct payroll for employees of conservation lands and organizations in the region. The overall summary of each of these values is in Table 3.8. Caution should be used when combining values from different methodologies, as not all are based on market prices, and represent a combination of willingness to pay and willingness to accept compensation values, which are not necessarily equivalent.

Table 3.8. Summary of economic values on conserved lands in Downeast Maine

Economic Value	**Value in 2017**	**Hancock County**	**Washington County**
Ecosystem Services: Direct Market Estimation Methods			
Blueberry Harvest	$4,441,694	$2,138,685	$2,303,009
Timber Harvest	$17,500,000	N/A	N/A
Carbon sequestration by forests	$42,189,413	N/A	N/A
Visitor spending	$304,427,778	$296,963,195	$7,464,585
Conservation Employment	$13,903,184	N/A	N/A
Ecosystem Services: Benefits Transfer Methodology			
Recreation, all types	$57,852,801	$39,873,910	$17,978,905
Science and Education	$5,029,885	$3,158,958	$1,870,926
Beach Access	$1,034,288	$880,570	$153,718
Clean water (water purification)	$11,292,662	$7,120,383	$4,172,278
Water supply (water provisioning)	$5,519,072	$4,029,482	$1,489,591
Wildlife Habitat provision	$33,654	$21,136	$12,518

Acadia National Park in Hancock County dominates the visitor spending effects and employment totals calculated in the study region. According to the NPS, in 2017 Acadia had 3.5 million visitors who spent approximately $284 million in local gateway communities. These expenditures supported a total of 4,160 jobs, $108 million in labor income, $185 million in value added, and $339 million in economic output in areas surrounding the park (NPS, 2017). Employment sectors that were directly affected included camping, gas, groceries, hotels, recreation industries, restaurants, retail and transportation.

This study found that Acadia National Park represented the majority (96%) of the visitor spending effects calculated for Downeast conserved lands at over $291 million in 2017. Employment at Acadia National Park in 2017 provided full- and part-time jobs for 278 people, representing wages and benefits totaling over $10 million. This represents 63% of the jobs calculated for Downeast conservation lands, and 71% of the wages and benefits.

These figures are an upper-bound estimate, however, as Acadia National Park tracks the visitor numbers needed for spending effects calculations and was able to provide up to date employment information. Similar data for private conserved lands, and many state and locally-owned public lands were not available, and therefore those parcels received a value of zero or a conservative estimate in the calculations for visitor spending effects and employment.

CHAPTER 4 COMMUNICATION AND OUTREACH

4.1 Introduction: Making Ecosystem Services Valuation Actionable

The purpose of this chapter is to present a communication and outreach framework that will facilitate the “operationalization” of these results for effective natural resource governance in the Downeast Maine region. It is important to consider the various decision demands that will be placed on these ecosystem services valuation results, and the subsequent format of presenting the information that should be provided. Elements of dignity theory, trust theory, post-structuralism and other relevant frameworks are applied in this discussion. Best practices are proposed to help stakeholders prevail over barriers and achieve a shared understanding of contentious issues among stakeholders leading to effective governance.

4.1.1 How Do We Create Knowledge That Will Be Used?

Linking science and decision-making (Cash et al., 2002), creating “actionable knowledge” (Brunet et al., 2018), or operationalizing the ecosystem services concept (Jax et al., 2018; Saarikoski et al., 2018) are not always accomplished. It is an ongoing challenge that the foremost available scientific research is not necessarily applied by its intended end-users (Wilbanks & Kates, 2010). The increase in the number of studies using ecosystem services valuation has not been shown to correspond to the application of the concept in actual decision-making contexts (Posner et al., 2016; Torres & Hanley, 2017).

This chapter attempts to answer the following questions: What are important considerations for advancing the implementation of this information in a decision-making setting to the benefit of a wide range of community stakeholders? What frameworks, tools, and methodologies can be applied to facilitate effective local governance of shared natural resources?

4.1.2 What Are the Potential Applications of These Results?

The results of this ecosystem services valuation study have a wide range of possible applications including informing and influencing policy (Fisher et al., 2008), raising awareness about the interdependence of humans and the environment (Crouzat et al., 2018; McKenzie et al., 2014), reframing conversations (McKenzie et al., 2014), supporting decision-making (Mace, 2014), and advancing the sustainable management of common pool resources (Crouzat et al., 2018). Advantages of applying the ecosystem services concept include the potential for increased communication and participation, improved awareness, enhanced collaboration, and an output of science-based, spatially-referenced knowledge (Dick et al., 2018).

Iniesta-Arandia et al. (2014) identified five potential stakeholder groups in their evaluation of stakeholder perceptions of the ecosystem services concept. These included locals dependent on provisioning services, locals not directly dependent on provisioning services, environmental and local development professionals, rural tourists, and nature tourists. Potential end users of this knowledge include civil society (land trusts, local, state and national conservation organizations), community-affected stakeholders such as local residents, schools, businesses, special interest groups, farmers, fishermen, tourists, institutional partners (e.g. University of Maine and Schoodic Institute), local and state governments, regulators, and local indigenous communities.

4.2 Considerations

A number of topics should be considered in crafting an outreach and communication implementation plan. The following information draws from multiple frameworks designed to facilitate linking knowledge and action around key values and practices, including boundary management, honest brokering, dignity, and trust.

4.2.1 Values

All science is value-laden, and when uncertainty is high, related policy-making is often value-driven as well (Johnson, 2015). Socio-cultural and economic influences can lead different stakeholders to attach different values to various ecosystem services (Hein et al., 2006).

In his book *The Honest Broker* (2007), Pielke proposes that science must include a consideration of values. This is known as post-structuralism. He suggests that science can only compel action in situations of general value agreement and low uncertainty, and that good decision-making requires an understanding of the political environment. Controversial issues lead to dynamics that rarely involve value consensus. Crouzat et al. (2018) build on Pielke's position in support of the post-structuralist viewpoint, reinforcing that values cannot be separated from ecosystem services and sustainability science. Anderies, et al. (2011) found that robust patterns demonstrating effective governance are hard to identify because they are so closely dependent on the specific socio-ecological context.

Pielke (2007) encourages scientists to think beyond the "linear model" where knowledge is created and handed down to policy-makers for implementation. He characterizes four roles a researcher might play at the science-policy interface based on two key factors: the degree of values consensus and the level of uncertainty.

In cases of high values consensus and low levels of uncertainty, the linear model does apply, and researchers may successfully play the role of *Pure Scientist*; however, such instances are rare. However, in situations of low values consensus and high uncertainty, such as often exist in ecosystem services valuation, Pielke suggests that researchers adopt the *Honest Broker of Policy Initiative*s model. Honest Brokers consider stakeholder values and concerns, and take an interdisciplinary approach, offering multiple options for application of scientific knowledge.

4.2.2 Scale

Wilbanks and Kates (1999) said it succinctly: scale matters. Challenges across a range of scales have been identified as major sources of misunderstanding in governing natural resources (Ostrom, 1999; Cash et al., 2006a). Cash et al (2006a) point out that whereas spatial, temporal and jurisdictional scales have received the most attention in scientific literature, institutional, management, networks, and knowledge scales are also important variables that warrant consideration in planning. Johnson (2015) adds demographic scale, such as population density and composition, to this list.

In an example of the challenges of mismatched scale, the spatial scale at which services are supplied by ecosystems and demanded by institutions has been shown to influence their valuation. Local stakeholders, such as individuals, families or local municipal governments, place higher value on provisioning services; however, institutions at global and national levels value regulating or cultural services at a higher level (Hein et al., 2006; Martin-Lopez et al., 2007). Adding to the disconnect between local and broader scales, Norton, et al. (2016) found that ecosystem service indicators derived at a national scale may not be particularly relevant on a local scale. They report that in-depth, locally-based research that engages stakeholders early in the process provides the opportunity for developing a more relevant ecosystem service evaluation. Wilbanks and Kates (1999) highlighted the link between local and global scales, suggesting that global environmental efforts would benefit from a “bottoms-up” approach of local data collection and analysis.

Temporal scales or “time frames” also impact ecosystem service delivery. Different services may be provided over months, years, or generations. Ecosystem service supply may vary over time due to such factors as fluctuations in weather patterns or overexploitation (Hein, et al., 2016). Hein et al. also found that demand for, and subsequently the value of, ecosystem services may vary considerably over time. Johnson (2015) points out that a misalignment of temporal scales related to policy and regulation may also occur. She gives the example of regulatory measures that are at times temporally disjointed from the actions of the fishing industry.

The scale of governance has received considerable attention. In 1990, Elinor Ostrom published her seminal work, *Governing the Commons*. Her research was a response to Garrett Hardin's "Tragedy of the Commons" (1968), which has come to represent the failure of individuals to responsibly manage shared resources, instead acting in their own self-interest until the resource has been depleted or destroyed. Ostrom (1990) countered the fatalism of the "Tragedy of the Commons," proposing that successful, rational, self-governance of common pool resources is possible, provided that issues related to supply, credibility and monitoring are addressed and resolved. Protection of ecosystem services on conservation lands can be an example of this type of common-pool resource governance. Ostrom drew important connections between scale of government and the associated relevant information needs; local priorities are best determined locally. Many have built upon Ostrom's work over the past few decades (see Anderies et al., 2011; Cash et al., 2002; Johnson, 2015). Johnson (2015) pointed out a challenge of scale that occurs when small rural municipalities are burdened with directives from state and federal agencies, without being given the requisite tools, education, or resources to fulfill such mandates.

4.2.3 Framing

The framing of ideas and information is a critical consideration in communicating these results. Johnson (2015) defines a frame as "a socially constructed perspective on an issue, problem or idea" (p.63). The way information is presented, or "framed", can enhance or undermine collaborative decision-making (Opdam et al., 2015). Borie and Hulme (2015) found that differing world views led to disputes about ecosystem services. Johnson (2015) explains that it is important for information to be presented in ways that address stakeholder priorities and concerns, as careful framing can help prevent unproductive discourse.

4.2.4 Uncertainty

According to Pielke (2007) uncertainty means there is more than one possible outcome; decision-making and policy-making are the process of managing uncertainty. It has become widely accepted that uncertainty is inherent in all scientific research. However, whereas scientists increase their credibility and are more trusted upon acknowledging uncertainty in their work (Cvitanovic et al., 2014; Fiske & Dupree, 2014; Lacey et al., 2015), the science itself becomes less trusted (Oreskes, 2004; Boschetti et al., 2016). Pielke (2007) stresses the importance of researchers understanding how uncertainty in their work will affect the decision-making process.

Pielke (2007) points out that efforts to reduce uncertainty often have the opposite effect by emphasizing competing group perspectives, and that sometimes uncertainty cannot be reduced. Science is often diverse, complex, and uncertain enough to sustain multiple arguments (Sarewitz, 2000). Pielke also suggests that reducing uncertainty does not create political consensus, and science should not be used as a tool for partisan battles: it should not be "cherry-picked", spun, stretched, or otherwise misused. As long as there are different, valid scientific opinions, uncertainty will be present as well (Sarewitz, 2000). How effective science will be in decision-making depends on the level of shared values and uncertainty. If uncertainty is fundamental and irreducible, science may play a limited role in the democratic process (Pielke, 2007). In other words, the results of this study must be presented with careful consideration to maximize their use in decision-making based on stakeholder values, recognizing that those values will be variable and the estimated benefits are inherently uncertain.

4.2.5 Dignity

The role of dignity in effective local governance has received limited attention. Drawing on the works of Ostrom (1990) and Hicks (2011), Johnson (2015) evaluated the ways in which dignity impacts effective governance of common pool resources. Dignity is defined as “an internal state of peace that comes with the recognition and acceptance of the value and vulnerability of all living things” (Hicks, 2011, p.1). Hicks’ work is grounded, in part, in the philosophies of Immanuel Kant. At the core of deontological moral philosophy is Kant’s *categorical imperative,* often referred to as an improvement on The Golden Rule, which states: "Act only according to that maxim whereby you can at the same time will that it should become a universal law" (Kant, 1785).

Hicks identifies ten essential elements of dignity. In her 2015 dissertation, Johnson incorporated Hick’s elements of dignity into Ostrom’s common-pool resource management strategy. Johnson lists accountability, independence, and inclusion as key elements of dignity that should be considered prior to undertaking a collaborative governance process (see Table 4.1).

Table 4.1. Aligning Ostrom's elements of effective governance with Hicks' elements of dignity (from Johnson, 2015)

Elements of Effective Governance (Ostrom, 1990, p. 90)	Elements of Dignity (Hicks, 2011)	Information Feedback about Dignity (Ostrom, 1990; Simon, 1986)
1. Clearly defined boundaries	Inclusion, independence	Limits extent of needed feedback: bounded rationality
2. Congruence between appropriation & provision rules and local conditions	Fairness	Retains realistic perceptual scale
3. Collective-choice arrangements	Inclusion, accountability, independence	Agility in acting on feedback
4. Monitoring	Accountability, fairness	Provides information on respect of dignity among participants
5. Graduated sanctions	Accountability, fairness	Provides information on respect of dignity within the governance process
6. Conflict-resolution mechanisms	Accountability, fairness	Provides information on respect of dignity within the governance process
7. Minimal recognition of rights to organize	Acceptance, recognition, fairness, independence	Provides information on respect of dignity of hierarchy
8. Nested Enterprises	Acceptance, recognition, fairness, independence	Scale of governance conducive to feedback, dignified action on feedback

4.2.6 Trust

A significant body of literature points to trust as a keystone for effectively linking science and decision-making (e.g. Pielke, 2007; Cvitanovic et al., 2014); however, there is no consistently accepted definition of trust in natural resource management. Several researchers have broken trust down into multiple dimensions (e.g. Smith et al., 2013; Stern and Coleman 2015). Smith et al. (2013) indicate that a belief in shared values has a significant impact on stakeholder trust in management agencies.

Others have identified distrust, or “skepticism” more specifically, as a critical component for enhancing co-production of knowledge and decision-making (Parkins, 2010; Smith et al., 2013; Parkins et al., 2017). Boschetti et al. (2016) found a lack of empirical evidence to guide trust-building efforts, as it has rarely been measured in the context of environmental decision-making. Their literature review found that trust is often assumed to be desirable, and is generally deduced, rather than measured.

4.2.7 Credibility, Legitimacy and Salience

Scientific knowledge is more likely to be used by decision-makers if they perceive it to be credible, salient and legitimate (Cash et al., 2002; Heink et al., 2015; Posner et al., 2016). In their seminal work from 2002, Cash et al. define credibility as the creation of believable, trusted information; salience as the relevance of information to decision-making; and legitimacy as the level of fairness of a process. They refer to these as the “three pillars of knowledge production” (p. 4), and point out that knowledge can only be successfully connected to action when efforts are perceived as credible, salient and legitimate by multiple stakeholder audiences. There are trade-offs between these three qualities and efforts to improve one may impact another either positively or negatively.

Posner et al. (2016) found that credibility, saliency and legitimacy increased the operationalization of ecosystem services research. They conducted interviews on decision-maker attitudes about the use of ecosystem services knowledge, and found that decision-makers first needed to assess the credibility of the results, and occasionally make modifications, prior to applying the concepts to policy-making. Cash (2002) points out that all three of these factors are scale dependent.

Heink et al. (2015) clarify the concepts of credibility, relevance (salience) and legitimacy, and demonstrate the limitation of how they can be understood and applied in different ways. However, they also report that these concepts can serve as boundary objects (as described below), as they are primary concerns for all involved stakeholders.

4.2.8 The Loading Dock Problem

In 2003, Cash et al. identified what has become known as The Loading Dock Problem. Scientific research is often conducted in a silo of academia, with little engagement between researchers and end-users of the information. Knowledge is created, and then dumped "as is" onto the “loading dock” for the end-users to interpret and apply. The loading dock problem creates dissonance for the necessary salience, legitimacy and credibility of the information. Beier et al. (2017) offer a clear example of how the loading dock problem occurs. Government organizations offering RFPs (requests for proposals) seek scientists who will create information which is then published in peer-reviewed journals. These authors refer to peer-reviewed journals as “big loading docks” where information sits waiting for a decision-maker to find it. Realistically, end-users such as land conservation staff, municipal employees, and economic development experts are unlikely to comb through academic literature for such insights.

Pielke (2007) points out that the loading dock problem is grounded in the belief that scientists should remain unbiased, and therefore removed from, the policy arena. However, he argues that we cannot separate ourselves from our values, and therefore bias is inherent in all research.

4.3 Recommendations for Communicating Ecosystem Services Valuation

> *"The concept of ecosystem services involves core principles that emphasize a need to adopt integrated approaches and deliver mutual benefits for diverse social groups."*
>
> *(Carmen et al., 2018, p.448)*

There is a growing body of research on the implementation or operationalization of the ecosystem services concept in land use policy, planning and decision-making (Blicharska & Hilding-Rydevik, 2018; Brunet et al., 2018; Carmen et al., 2018; Coleman & Stern, 2018; Dick et al., 2018; Gret-Regamey et al., 2017; Jax et al., 2018; Olander et al., 2017; Posner et al., 2016; Saarikoski et al., 2018; Schirpke et al., 2017; Tammi et al., 2017). The following recommendations draw from this body of literature, and build on the frameworks discussed in Section 4.2.

Remote, rural communities, such as those found in the Downeast Maine region, experience real challenges to their land use planning and policy decision-making. Intergenerational poverty, a lack of knowledge and technical information, limited government capacity, and a heavy dependence on limited common pool resources are a few factors that can lead to undignified battles in rural governance (Johnson, 2015). Ecosystem services are a human-centric concept, defined around human benefit. The ecosystem services framework therefore has the ability to demonstrate how these limited resources directly affect stakeholders in the region. These factors were kept in mind along with the previously reviewed literature when generating these recommendations.

To facilitate decision-making between stakeholders with a wide range of values, and to increase the application of ecosystem services information, the following strategies are recommended.

- Conduct collaborative planning, forming transdisciplinary partnerships that are self-organized, and bridge boundaries across different ways of knowing (Cash et al., 2006b; Johnson, 2015; Dick et al., 2018).
- Maximize strategies that emphasize dialogue and interaction between diverse constituents. Minimize use of tools applying one-way information sharing flows (e.g. public opinion polls, focus groups, surveys, public hearings) (Innes & Booher, 2004).
- Ensure that decision-makers play an active role in ecosystem services research so as to increase its application and use (Johnson, 2015; Wright et al., 2017).
- Create facilitator-led, stakeholder-driven, agreed-upon procedures and rules for communicating during the process to ensure fairness and transparency (Coleman & Stern, 2018).
- Create opportunities for stakeholders to share information in a structured environment. For example - host a formal interactive group dialogue about project goals and objectives. Determine how goals are interpreted by different members. Ascertain what constituents personally hope for regarding outcomes. Co-contribute to the creation of project documents and materials (Coleman & Stern, 2018).
- Plan “informal interactions” that highlight shared interests, such as field trips. The goal is to achieve consensus. Create opportunities for stakeholders to talk, share ideas, communicate opinions, and ask questions; this increases learning and builds confidence

in others’ abilities to perform their jobs with skill and competence (Coleman & Stern, 2018).

- Have conversations to develop a mutual understanding of goals (Bieluch et al., 2017; Coleman & Stern, 2018).
- Where values conflict, provide choices of alternative courses of action that can accommodate multiple (potentially competing) perspectives. Providing choices allows stakeholders the opportunity to make a decision based on their own values, priorities, and ideals (Ostrom, 1990; Pielke, 2007; Johnson, 2015).
- Align scale of governance with scale of resources. Decisions about locally-experienced ecosystem services should be made by individuals or municipalities. Have many small centers of governance, by engaging with individuals and organizations where impacts are felt (Ostrom, 1990; Cash et al., 2006a; Johnson, 2015).
- Create tight information feedback loops, which can facilitate governance by allowing close observation and involvement by stakeholders. One way to promote information feedback loops is through a series of facilitator-led public discussions (Ostrom, 1990; Johnson, 2015).
- Maps and other information should be presented at a scale appropriate to stakeholder decision-making needs (Cash et al., 2006a; Johnson, 2015).
- It is critical that the language used to communicate ecosystem services information be framed differently for various stakeholder audiences, speaking in the voice of the intended recipient and avoiding unfamiliar jargon. Frame the discussion around current, local vulnerabilities and priorities, and avoid framing communications around polarizing issues (Johnson, 2015; Natural Capital Coalition, 2016; Carmen et al., 2018; Jax et al.,

2018). This necessitates having multiple outreach platforms adapted to meet the norms, cultures, knowledge needs and understanding of the various stakeholder groups.

- Apply boundary spanners, which may include individuals, objects, organizations, or tools and methods (Cash et al., 2002; Carmen et al., 2018; Coleman &Stern, 2018). Boundary spanners may serve several functions, including information sharing, compromise negotiation, and facilitating trust (Kapucu, 2006; van Meerkerk & Edelenbos, 2014; Coleman & Stern, 2018). Two frequently recommended boundary objects are maps and scenarios (McKenzie et al., 2014; Johnson, 2015; Brunet et al., 2018).
- When introducing the results of this study to the community, the Downeast Conservation Network might consider creating a transdisciplinary working group to serve as a liaison in presenting the information during early phases of discussions. Working group members should represent the diverse range of stakeholders in the region, and include professionals from various fields who are able to interpret the various scientific concepts.

CHAPTER 5 DISCUSSION AND CONCLUSIONS

5.1 Discussion

This research project represents, to our knowledge, the first economic assessment of the values provided by conserved lands in the Downeast Maine region. The amenities offered by these lands are key economic drivers that contribute hundreds of millions of dollars each year in benefits to the surrounding communities and beyond. These values encompass both market and non-market goods and services. The variables measured here were stakeholder-driven, and represent just a fraction of the total economic value provided by these lands.

This study has parallels to Troy's report (2012) for the Manomet Center for Conservation Sciences entitled Valuing Maine's Natural Capital. Troy also applied spatial value transfer methodology as originally described by Troy and Wilson (2006) to assess ecosystem services for the State of Maine. Troy first defined the study area and developed a customized typology of ecosystem services. He then applied Manomet's proprietary Natural Assets Information System (NAIS) to conduct a literature search for identification of ecosystem services by land cover type. (During the course of this project, it was discovered that several such proprietary databases exist that do not provide access to the general public.) The present study differed in the use of publicly available valuation databases, including OSU's Recreational Database, the Environmental Valuation Research Inventory (EVRI), and the USGS Benefit Transfer Toolkit, in order to improve replicability and transparency of the study. Additionally, the present study was very conservative in the selection of applicable proxy values from the literature base. Whereas Troy (2012) was comprehensive in applying values derived for ecosystem services around the country and the world, this project was much more conservative, limiting value transfers to primary studies conducted in New England, and select areas of Canada and Minnesota with similar geographic and socioeconomic characteristics.

The majority (72.4%) of conserved lands in the study region are classified as forest. The next largest class of conserved land cover is wetlands, which comprise 18.74% of the total. All other land cover types combined provide the remaining (roughly) 10% of conserved lands. In the two-county Downeast region, 19.4% of the total land area is held in some type of land conservation status, with 12.5% of Hancock County and 25% of Washington County protected. There is roughly a 60/40 breakdown of lands held in conservation easements vs. fee acquisition, and roughly a 60/40 breakdown between privately held lands and those under government stewardship.

Downeast Maine has grown at a slower rate than the rest of the state and the rest of the United States (Hassan et al., 2010). The socio-economic and demographic characteristics of the Downeast Maine region are quite different between the two counties, with Washington County depressed in all aspects compared to Hancock County. Between 2000 and 2016, Washington County experienced a population decline while Hancock County grew. Although 88.5% of adults in both counties have at least a high school diploma, only 19.9% of adults in Washington County have degrees of a bachelor's or higher. In Hancock County, 28% of the population has reached at least the bachelor's degree level of education.

This trend continues in the workforce. In 2016, fewer individuals participated in the workforce in Washington County (52.85%) compared to Hancock County (57.47%), with unemployment in Washington County at 8% and in Hancock at a more reasonable 5.2%. The median household income for Hancock County was $7,155 higher than in Washington. The poverty rate in Washington County was higher (15.84%) than in Hancock County (11.72%), although both counties showed a very high rate of child poverty at approximately 17%.

The 2016 housing markets in the two counties were also quite different, with a median household value of $109,167 in Washington County, and $200,334 in Hancock County. The number of housing units in Hancock County was almost double that of Washington County. The percent of housing units occupied was, however, similar between the two counties with Washington at 61% and Hancock at 59%.

Historically, natural resource extraction has provided the bulk of jobs in the employment sectors of Downeast Maine (Hassan et al., 2010). An analysis of the breakdown between employment sectors for 2016 indicates that this is no longer the case, similar to most rural communities in the United States. In Downeast Maine, the highest level of employment is found in the educational services, healthcare, and social assistance sector, with both counties near 27%. The retail industry is now the second largest employment sector in the region (11.6% and 12.9% for Washington and Hancock, respectively.) In 2016, agriculture, fisheries, forestry and mining in Hancock County represented just 5.6% of employment. Washington County continues to be more reliant on resource extraction with 12.2% of employment occurring in that sector. The region supports commercial fishing, agriculture (e.g. blueberries), and timber production.

In addition to an unequal economic distribution within the region, there is also the naturally-occurring unequal distribution of environmental resources. Land ownership parameters may limit natural resource access for the most vulnerable segments of the population.

Of the ecosystem services that were evaluated in this study, recreation provided the highest level of economic benefit at $57,852,801 for 2017. This included the value provided by general recreational access; camping; non-motorized boating; deer, moose and black bear hunting; access to areas with migratory fish; fresh and saltwater angling; and recreational water quality. The value of beach access could not be fully captured due to the lack of data on number of beach visitors; however, it is likely to be high, given the scarcity of beaches and their popularity as recreation sites in the Downeast region. Recreation measured use by visitors and locals alike. Most of these recreational opportunities are available at low or no-cost. This report represents a lower-bound estimate of recreational benefits, as a limited number of activities were represented in the applicable primary literature. The recreational value was not captured for wildlife watching, hiking, cycling and mountain biking, snowmobiling, photography, rock climbing, and more.

Visitors to conservation lands in the region spend considerable money and time in the surrounding gateway communities. By applying an adapted version of the U.S. National Park Services Visitor Spending Effects (VSE) Model, a value of $304,427,779 was attributed to visitor spending related to use of conserved lands in the Downeast region. This is a low estimate as it is based on visitor use numbers, which are not collected for many public and private properties. This VSE total also does not include taxes paid on the over $304M in spending.

During the planning phases of this study, stakeholders identified several key questions. Each of these is addressed below.

1. What is the benefit of a conservation parcel?

Conserved lands in the Downeast region provide a wide range of recreational, scientific, educational, environmental, and direct use benefits. Similar to Brown and Shi (2014), placing these lands in conservation ensures the ongoing provision of a high level of ecosystem services that are critical to quality of life, including providing a source of clean water, and cleaning the air through carbon sequestration. Conserved lands also preserve the Downeast Maine region's natural beauty, providing habitat for wildlife that attract hunters and wildlife-watchers alike, and offering the source of attraction for many of the area's visitors each year. The spending effects from these visitors bring considerable income to the region.

Conserved lands do offer some benefit to local communities beyond those measured in the marketplace. The full value of conservation lands is situationally-dependent on socio-economic, demographic, and geographical variables. Most of these benefits are value-laden and perceived differently by various stakeholder groups. Ultimately the answer to this question depends on the values and perspective of the individual being asked. Our conservative analysis indicated that the non-market benefits of conserved lands in the region were at least $80,762,362 per annum, market values were approximately $64,131,107, and visitor spending accounted for a further $304,427,778 in value to the region.

2. What is the contribution of conservation employment to the study region?

Employment in conservation is important to the Downeast Maine area. When lands are put in conservation, there are jobs associated with managing and stewarding these properties. Employment directly related to conservation lands in the region provided a minimum of 440 full and part-time positions with salaries and benefits of $13,903,184 in 2017. This is a lower-bound estimate. These results indicate that transfer of land to conservation does not result in a total loss of jobs. Additionally, this employment data does not include jobs that result from associated activities on conserved lands, including hunting and tour guides and outfitters, retail stores that serve recreation, lodging for visitors, gas, food establishments, and more.

3. What is the cost of removing conserved lands from the tax rolls?

Calculating the exact impact of putting lands in conservation and removing them from municipal tax rolls was beyond the scope of this study. The actual impact will depend significantly on a number of factors, including estimating what the trajectory of municipal taxes would be in the absence of conserving lands (a prediction of the trajectory of land development and valuation in an uncertain, hypothetical future). It should be noted that the question was posed exactly as phrased, with the value-implied assumption that there is a *cost* for conserving land, as opposed to a benefit from their preservation. It is possible that the non-market values that accrue to the population due to conservation outweigh the reduction in municipal revenues, although there is some disconnect between who receives the costs and benefits, both monetary and non-monetary, in this case.

Nonprofit conservation organizations may elect to voluntarily make PILOTs (payments in lieu of taxes) to local municipalities. However, Maine's Joint Standing Committee on Agriculture, Conservation and Forestry (2018) found that this occurs for just 4% of conserved lands statewide. However, according to Johnson (personal communication, 01/13/2019), the vast majority of privately-held conservation lands in the study region are held by state or national NGOs who voluntarily make PILOTs, with the exception of a small number of local land trusts. These PILOTs are still just a fraction of the fully-assessed value due to much of the land being enrolled in one of Maine's current use tax programs (see below.)

More significant is the rate of participation in Maine's four current-use tax programs. As described by Maine's Joint Standing Committee on ACF (2018), Maine offers property owners a reduction in their assessed land value through four programs: Tree Growth, Open Space, Farmland Tax Law, and Working Waterfront (see Box 5.1). The Tree Growth Tax Law applies land valuation based on working forest land productivity, and as required by Maine Revised Statutes Title 36, Section 578, 90% of tax revenue lost to this program is reimbursed to the respective municipalities. This is particularly relevant to conserved lands in Downeast Maine.

The Maine Land Trust Network (MLTN, 2017) reports that working forestlands comprise more than 85% of the total acreage held by private land trusts in the state; these lands are not restricted from harvest as a condition of the conservation easement. This study found that 72.4% of conserved lands in the Downeast region are forested. If 85% of these are working forests, then an estimated 61.54% of conserved lands in Downeast Maine fall into that category, and have 90% of lost tax revenue returned to the municipality. Therefore a full 55% of all tax revenue lost to conservation in the Downeast region may be returned to local governments through the State of Maine's Tree Growth Tax Law.

Conservation easements are effective planning tools that can also leverage outside funding (Paul, 2011). Conservation easements have also been shown to hold value in protecting working lands, including working forests and working waterfronts in the study region.

Case study: Maine's Working Waterfront Access Protection Program (WWAPP)

Through a competitive application process, matching funds are available to assist commercial fisheries businesses, co-ops, municipalities, and other interested parties in securing strategically-significant working waterfront properties to protect vital resources such as access that support commercial fisheries. Funds can be used to purchase property, or for the purchase of access easements, rights of way, or development rights to preserve walk-in or small boat access, properties entirely dedicated to commercial fisheries uses, or mixed-use properties. Department of Marine Resources (DMR) sponsorship is required (Maine Department of Agriculture, Conservation and Forestry, 2018). As of December 2017, there were five WWAPP projects in Washington County, and in Hancock County (Land for Maine's Future, 2018).

The following six working waterfronts participate in Maine's WWAPP:

1. David Wharf, Tremont, Hancock County, 0.6 acres

2. The Wharf on Johnson Bay, Lubec, Washington County, 1.0 acre

3. Moosabec Mussel, Jonesport, Washington County, 0.8 acre

4. Quoddy Bay Lobster, Eastport, Washington County, 0.94 acre

5. Great Wass Lobster & Bait Co., Beals, Washington County, 1.0 acre

6. Beals Town Landing, Beals, Washington County, 0.5 acre

Total Working Waterfront conserved in the Downeast Region: 4.84 acre

5.2 Comparison With Other Studies

Comparing the results from this study to others can validate the amounts calculated here. Results of this study indicate that conservation land in Downeast Maine provide a total of over $463 million per year in ecosystem service benefits, including both market and non-market values, and the more than $300 million of visitor spending in the region. Based on the estimate of 702,654 acres of conserved land in the study area, this equates to an average value of $652/ac/yr. If values associated with visitor spending are ignored, then this estimate reduces to about $200/ac/yr. This latter value is closer to the methods and categories used in other ecosystem service valuation studies conducted elsewhere, and thus more comparable. As a majority of the conserved land in Downeast Maine is forested, we focus on a comparison here with other studies that featured that ecosystem (See Table 5.1).

Many studies have used similar benefits transfer methods to estimate the value of ecosystem services at the global (e.g., Costanza et al., 2014; de Groot et al., 2012) and regional scale (e.g., Troy, 2012). For example, Troy (2012) used a benefits transfer approach based on values taken from studies in temperate areas of central and eastern North America, northern Europe, and New Zealand to estimate the value of non-market ecosystem services for the entire state of Maine.

Table 5.1. Summary of forest ecosystem service valuation studies

Study	**Ecosystem**	**Region**	**Value, 2016$/ac**
This study	All	Downeast ME	$652
This study	All, non-market	Downeast ME	$199
deGroot et al., 2012	Temperate forests	Global	$1,405
deGroot et al., 2012	Woodlands	Global	$741
Costanza et al., 1997	Temperate/Boreal	Global	$194
Costanza et al., 1997	Temperate/Boreal	Global	$1,463
Troy, 2012	Streamside forest	Maine	$1,425
Troy, 2012	Harvested forests	Maine	$120 - $313
Troy, 2012	Non-urban forest	Maine	$482
Troy, 2012	Suburban forest	Maine	$3,217
Troy, 2012	All forests	Maine	$480
Daigneault & Strong, 2018	All forests	Sebago Lake	$867
Escobedo & Timilsina, 2012	Forest Stewardship Program Lands	Florida	$151
Moore et al., 2011	Private forests	Georgia	$1,709
Paul, 2011	All forests	Virginia	$880
Simpson et al., 2013	All forests	Texas	$1,489

Global studies estimate that temperate forests provide ecosystem services that value $194 to $1,463 (in 2016 USD) per acre per year, with more recent studies citing figures closer to the higher end (e.g., Costanza et al., 2014). In terms of the value of ecosystem services in Maine, Troy (2012) estimates that the 17 million acres of forests in Maine provide an average value of about $482/ac/year, but that this value can vary between $120 and $3,217/ac/year depending on the type and location of the forest. This wide variation values reflects both methodological and study scope differences as well as differences in the value of forests across the study regions.

In all of these studies, each research group made different choices about which services to include, regardless of geographic scope. Troy (2012) only included estimates of the non-use value of forests (e.g., aesthetic and cultural benefits), while others also included market values (e.g., provision of fuel and fiber). However, all studies estimated the value of forests for protecting water quality, regulating water flow, regulating climate change via carbon sequestration, and providing wildlife habitat or biodiversity.

The goal of this study was to present the most defensible estimate of the value of conservation lands. As such, only the most applicable primary sites were selected for benefits transfer, and only those ecosystem services that were both available from appropriate primary study sites and of interest to stakeholders were considered.

5.3 Challenges and Limitations

Mapping and valuing ES is complicated, presenting a wide range of challenges and limitations (Troy, 2012; Richardson et al., 2015, Burkhard & Maes, 2017). The most significant challenges and limitations faced by this study are discussed in this section.

Reliable data is crucial to conducting a quality assessment, and as indicated by Law et al. (2015), choices of data sources will result in different spatial patterns. However availability of and access to data remain central challenges to valuing and mapping ecosystem services. This study required the gathering of multiple data sets, including demographic, socioeconomic, geographic, ecological, and territorial information. Palomo et al. (2018) describe the complexities of gaining access to mapping data, which come from a wide range of institutions, with differing formal barriers, in a variety of formats and scales.

Options for identifying potential transfer values were limited to publically-available resources. Several value transfer databases identified in the literature were inaccessible as they are proprietary to their organizations (e.g. Earth Economics, Manomet).

With the application of LULC maps to spatial value transfer comes the potential for generalization error (Plummer, 2009; Andrew et al., 2015; Brown et al., 2016; Palomo et al., 2018). LULC classes actually contain heterogeneity within them that cannot be detected at more coarse scales. Generalization error occurs when the assumption is made that classes are homogeneous throughout. According to Plummer (2009), this is the key source of error in benefits transfer mapping. Spatial resolution determines the level of detail. Classes that are too coarse will obscure variation in ecosystem service supply (Koschke et al., 2012).

Benefit transfer relies on the application of suitable proxies, also known as "correspondence" between locations (Plummer, 2009). Plummer (2009) writes "the art of benefit transfer lies in finding ways to minimize transfer errors, while not expecting to eliminate them altogether" (p. 40).

5.4 Conclusions and Future Research

The biggest limitation to answering questions posed early in this study was a lack of applicable data. Enhanced data collection by the conservation community in the region and state would benefit future endeavors to assess property access and usage, and to calculate relevant economic variables. Conservation landholders could track data on who comes and goes through a variety of means (e.g. thermal cameras, low angle game cameras, electronic counters).

According to Maine's Joint Standing Committee on ACF (2018), the interaction between Maine's conservation organizations and local communities have generally been positive; however, a small number of towns reported feeling excluded from the decision-making process. One town official noted that "there has not been much conversation between the town and land conservation organizations," (p. 7) leading to frustration for the local community. To address these types of concerns, transdisciplinary research and decision-making is vital. Incorporating values with science is a necessity for successful natural resource governance. In general the field of ecosystem services would benefit from a greater sharing of resources and information, including benefit transfer reference databases and other tools.

The presence of Acadia National Park in Hancock County, the legacy of the forest industry in Washington County, and myriad other historical and current factors have had major socioeconomic consequences which are evident in both the census data and in the ways in which land is conserved and used in the two counties. These differences are important to keep in mind as the Downeast Conservation Network moves forward with discussion about topics such as the impacts of conserved lands on tax rolls, which was beyond the scope of this study. In Hancock County the value of conserved lands is more obvious and tangible than in Washington County. In Hancock County, income from fisheries and forestry has largely been replaced with tourism. In Washington County, the value of conserved lands is less evident. While Washington County also has a larger percentage of its land held in conservation, almost all of the conserved land in Washington County is privately held.

Whether or not conservation is valuable is not something that can be resolved by science alone, but rather will be based on individual perspectives. Science will not resolve political conflict because it provides an "excess of objectivity" that can support multiple, conflicting, subjective opinions (Sarewitz, 2000). Science is value-based and requires the political process of bargaining, negotiation, and compromise (Pielke, 2007).

In summary, ecosystem services provide considerable benefits to surrounding communities, some of which are obvious through being traded in the marketplace. Other benefits are less direct, but no less significant, including ecological services, visitor spending and employment. The ecosystem services framework provides a useful way to demonstrate many of these benefits from an anthropocentric perspective, making it an important tool for land-use decision-making.

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Land Cover Type	Ecosystem Service	Physical Amount (x)	Year	Unit $	Units	Original year	Transformed unit ($USD)	Year	Total $	Year	Notes	Author(s)	Title	Primary Study Geo Location
Open Water	Recreation - access to area with migratory fish	37,813	2016	$27.33	hh/yr	2008	$31.07	2017	$1,174,849.91	2017	23,748 hh in HaCo; 14,065 hh in WaCo from ACS 2016	Johnston, RJ et al	Indices of biotic integrity in stated preference valuation of aquatic ecosystem services	RI
Open Water	Recreational Fishing: Fresh & Salt	22,405	2016	$357	angler/season	1994	$589.67	2017	$13,211,556.35	2017	# units calculated from population for two counties in 2016 = 86,408; Pop for State of ME 2016 = 1,331,479; # anglers statewide 2016 = 345,251 (personal communication, Bill Swan, ME DIFW, 5/22/18)	Alberini, A., K. Boyle and M. Welsh	Analysis of contingent valuation data with multiple bids and response options allowing respondents to express uncertainty	ME
Open Water	Recreation - non-motorized boating	1	NA	$48.52	person/day	2016	$49.49	2017	$49.49	2017	Analysis is based on a mail survey of private boaters and commercial passengers; estimates probability of trip participation and consumer surplus of a whitewater trip to the Dead River in Maine as a function of instream flows. Unable to determine # persons.	Roach, et al.	The effect of instream flows on whitewater visitation and consumer surplus: A contingent valuation application to the Dead River, Maine.	ME
Open Water	Recreation - Water quality	1	NA	$110	user/year	1982	$279.03	2017	$279.03	2017	Recreation Benefits from an Improvement in Water Quality at St. Albans Bay, Vermont; unable to determine # users	Ribaudo, M. O. and D.J. Epp	The Importance of Sample Discrimination in Using the Travel Cost Method to Estimate the Benefits of Improved Water Quality.	VT
Open Water	Wildlife Habitat - migratory fish spawning habitat	37,813	2016	$0.78	hh/yr	2008	$0.89	2017	$33,653.57	2017	23,748 hh in HaCo; 14,065 hh in WaCo from ACS 2016	Johnston, RJ et al	Indices of biotic integrity in stated preference valuation of aquatic ecosystem services	RI
Forest	Water supply	205781.94	2017	$32.60	hectare/year	2012 Canadian	$26.82	2017	$5,519,071.63	2017	Headwater forests provide a reliable, plentiful water supply. Converted 508,498.25 acres to hectares. Converted Canadian 2012 $ to US 2017 $ on 6/7/18	Wilson, S.J.	The Peace Dividend: Assessing the Economic Value of Ecosystems in B. C's Peace River Watershed.	British Columbia, Canada
Forest	Recreation - Camping	1	NA	$14.53	person/day	2016	$14.82	2017	$14.82	2017	USGS database provides units as pp/day; dissertation available only on at Maine State Library in Augusta on microfilm or in special collections; unable to determine # campers	Seekins, M.D.	Seekins, M.D. 1981. An analysis of forest recreation in the north Maine woods. PhD dissertation. Orono, ME: University of Maine. 170p.	ME
Forest	Recreation - Deer Hunting	508,498.25	2017	$39	acre/year	2007	$46.04	2017	$23,411,259.43	2017	Land provides deer habitat	Knoche, S., and Lupi, F.	Valuing deer hunting ecosystem services from farm landscapes	MI
Forest	Recreation - Moose Hunting	139	2016	$724	moose hunter/year	1991	$1,301.21	2017	$180,868.19	2017	Study pop was "all moose hunters in Maine"; # units calculated from population for two counties in 2016 = 86,408; Pop for State of ME 2016 = 1,331,479;# moose permits allocated in 2016 was 2,140 (https://www.maine.gov/ifw/hunting-trapping/moose-permit.html#review)	Boyle, K. J., H. F. MacDonald, H. Cheng, and D. W. McCollum	Bid Design and Yea Saying in Single-Bounded, Dichotomous-Choice Questions	ME
Forest	Recreation - Black Bear Hunting	14,252	2016	$419	resident hunter/year	1995 Canadian	481.88	2017	$6,867,753.76	2017	# resident hunters based on population for two counties in 2016 = 86,408; Pop for State of ME 2016 = 1,331,479; # resident hunters in Maine 2016 = 219,612); personal communication, Bill Swan, ME DIFW, 5/22/18); Converted $419 1995 Canadian to 2017 Canadian = $624.43 (using Bank of Canada inflation calculator https://www.bankofcanada.ca/rates/related/inflation-calculator/. Then converted $624.43 Canadian to US for 2017.	Reid	Economic Value of Hunting in British Columbia; Conference report	British Columbia, Canada
Scrub/Shrub	Recreation - Deer Hunting	32,684.20	2017	$39	acre/year	2007	$46.04	2017	$1,504,780.57	2017	Land provides deer habitat	Knoche, S., and Lupi, F.	Valuing deer hunting ecosystem services from farm landscapes	MI
Grassland / Herbaceous	Recreation - Deer Hunting	6,971.73	2017	$39	acre/year	2007	$46.04	2017	$320,978.45	2017	Land provides deer habitat	Knoche, S., and Lupi, F.	Valuing deer hunting ecosystem services from farm landscapes	MI
Pasture / Hay	Recreation - Deer Hunting	986.02	2017	$39	acre/year	2007	$46.04	2017	$45,396.36	2017	Land provides deer habitat	Knoche, S., and Lupi, F.	Valuing deer hunting ecosystem services from farm landscapes	MI
Cultivated Crops	Recreation - Deer Hunting	579.42	2017	$39	acre/year	2007	$46.04	2017	$26,676.50	2017	Land provides deer habitat	Knoche, S., and Lupi, F.	Valuing deer hunting ecosystem services from farm landscapes	MI
Wetland	Clean Water	86,408	2016	$77.15	resident/year	1993	$130.69	2017	$11,292,661.52	2017	# residents is for both counties derived from ACS 2016	Stevens, T. H. and S. Benin	Public Attitudes and Economic Values for Wetland Preservation in New England	New England
Wetland	Recreation - Deer Hunting	129,743.08	2017	$39	acre/year	2007	$46.04	2017	$5,973,371.40	2017	Land provides deer habitat	Knoche, S., and Lupi, F.	Valuing deer hunting ecosystem services from farm landscapes	MI
Beach	Recreation - Access	1	NA	$3.17	beach visitor/yr	1995	$5.09	2017	$5.09	2017	Unable to deterine # beach visitors	Kline &Swallow	The Demand for Local Access to Coastal Recreation in Southern New England	MA
Acadia National Park	Recreation - access	37,813	2016	$119	hh/year	2008	$135.30	2017	$5,116,098.90	2017	23,748 hh in HaCo; 14,065 hh in WaCo from ACS 2016; this is use value	Wallmo, K. and S. Edwards	Estimating Non-market Values of Marine Protected Areas: A Latent Class Modeling Approach	Northeastern US (ME, VT, NH, MA, RI, CT, NY, NJ, DE, MD, DC, PA, VA, WV, and NC)
Acadia National Park	Science and Education	37,813	2016	$117	hh/year	2008	$133.02	2017	$5,029,885.26	2017	23,748 hh in HaCo; 14,065 hh in WaCo from ACS 2016; this is use value	Wallmo, K. and S. Edwards	Estimating Non-market Values of Marine Protected Areas: A Latent Class Modeling Approach	Northeastern US (ME, VT, NH, MA, RI, CT, NY, NJ, DE, MD, DC, PA, VA, WV, and NC)

APPENDIX A. Benefit Transfer Table of Values

APPENDIX B: Private Conservation Landholders in the Study Region

Organization	**County**	**Type**
Blue Hill Heritage Trust	Hancock	Local land trust, nonprofit
Crabtree Neck Land Trust	Hancock	Local land trust, nonprofit
Frenchmans Bay Conservancy	Hancock	Local land trust, nonprofit
Great Pond Mtn. Conservation Trust	Hancock	Local land trust, nonprofit
Island Heritage Trust	Hancock	Local land trust, nonprofit
Islesboro Islands Trust	Hancock	Local land trust, nonprofit
Maine Audubon	Washington & Hancock	Statewide nonprofit organization
Maine Coast Heritage Trust	Washington & Hancock	Statewide nonprofit organization
Maine Farmland Trust	Washington & Hancock	Statewide nonprofit organization
Maine Island Trail Association	Washington & Hancock	Statewide nonprofit organization
ME Woodland Owners (SWOAM)	Washington & Hancock	Statewide nonprofit organization
New England Forestry Foundation	Washington & Hancock	Regional nonprofit organization
Northeast Wilderness Trust	Washington & Hancock	Regional nonprofit organization
The Conservation Fund	Washington & Hancock	National nonprofit organization
The Nature Conservancy of Maine	Washington & Hancock	State chapter of national nonprofit
Forest Society of Maine	Washington & Hancock	Statewide nonprofit organization
Downeast Lakes Land Trust	Washington	Local land trust, nonprofit
Downeast Salmon Federation	Washington	Local conservation org., nonprofit
Downeast Coastal Conservancy	Washington	Local land trust, nonprofit
Pleasant River Wildlife Foundation	Washington	Local land trust, nonprofit
Woodie Wheaton Land Trust	Washington	Local land trust, nonprofit

APPENDIX C: State and Federal Conserved Landholders in the Study Region

Property	**County**
Cobscook Bay State Park	Washington
Shackford Head State Park	Washington
Ft. O'Brien State Historic Site	Washington
Quoddy Head State Park	Washington
Roque Bluffs State Park	Washington
Cross Island National Wildlife Refuge	Washington
Saint Croix Island International Historic Site	Washington
Moosehorn National Wildlife Refuge	Washington
Holbrook Island Sanctuary	Hancock
Lamoine State Park	Hancock
Acadia National Park	Hancock
Donnell Pond Public Reserved Land	Hancock
Duck Lake Public Reserved Land	Hancock
Petit Manan National Wildlife Refuge	Hancock
Downeast Sunrise Trail	Washington & Hancock

APPENDIX D: Socioeconomic & Demographic Characteristics of the Region

(All data from US Census Bureau ACS)

Indicator	**Washington County**	**Hancock County**
Population in 2000	33,941	51,791
Population in 2016	31,925	54,483
Change (#)	-2,016	+2,692
% with High School Diploma 2016	88.5%	88.42%
% with Bachelor's Degree or higher 2016	19.9%	28%
Labor Force Participation 2016	52.85%	57.47%
Unemployment 2016	8.01%	5.2%
Median Household Income 2000	$27,979	$34,293
Median Household Income 2016	$40,448	$47,603
Poverty Rate 2016	15.84%	11.72%
Child Poverty Rate 2016	17%	16.43%
Housing Units 2016	23.075	40,469
Housing Units Occupied 2016	14,065	23,748
Housing Units Vacant 2016	9,010	16,721
Housing Units Vacant (Seasonal) 2016	6,203	13,745
Median Household Value 2016	$109,167	$200,334

APPENDIX E: Downeast Employment by Industry and County

(All data from US Census Bureau ACS)

Industry	**Washington County**	**Hancock County**
Educational Services, Healthcare, Social Assistance	27.2%	26.7%
Arts, Entertainment, Recreation, Accommodations, Food Service	6.8%	11%
Public Administration	6.7%	3.1%
Agriculture, Forestry, Fishing, Hunting, Mining	12.2%	5.6%
Construction	6%	8.4%
Manufacturing	8.8%	5.6%
Wholesale trade	2.5%	1.5%
Retail trade	11.6%	12.9%
Transportation and warehousing, utilities	4%	3.5%
Information services	0.5%	1.6%
Fire	4.1%	4.2%
Professional / Management	4.9%	10.7%
Other	4.7%	5.1%

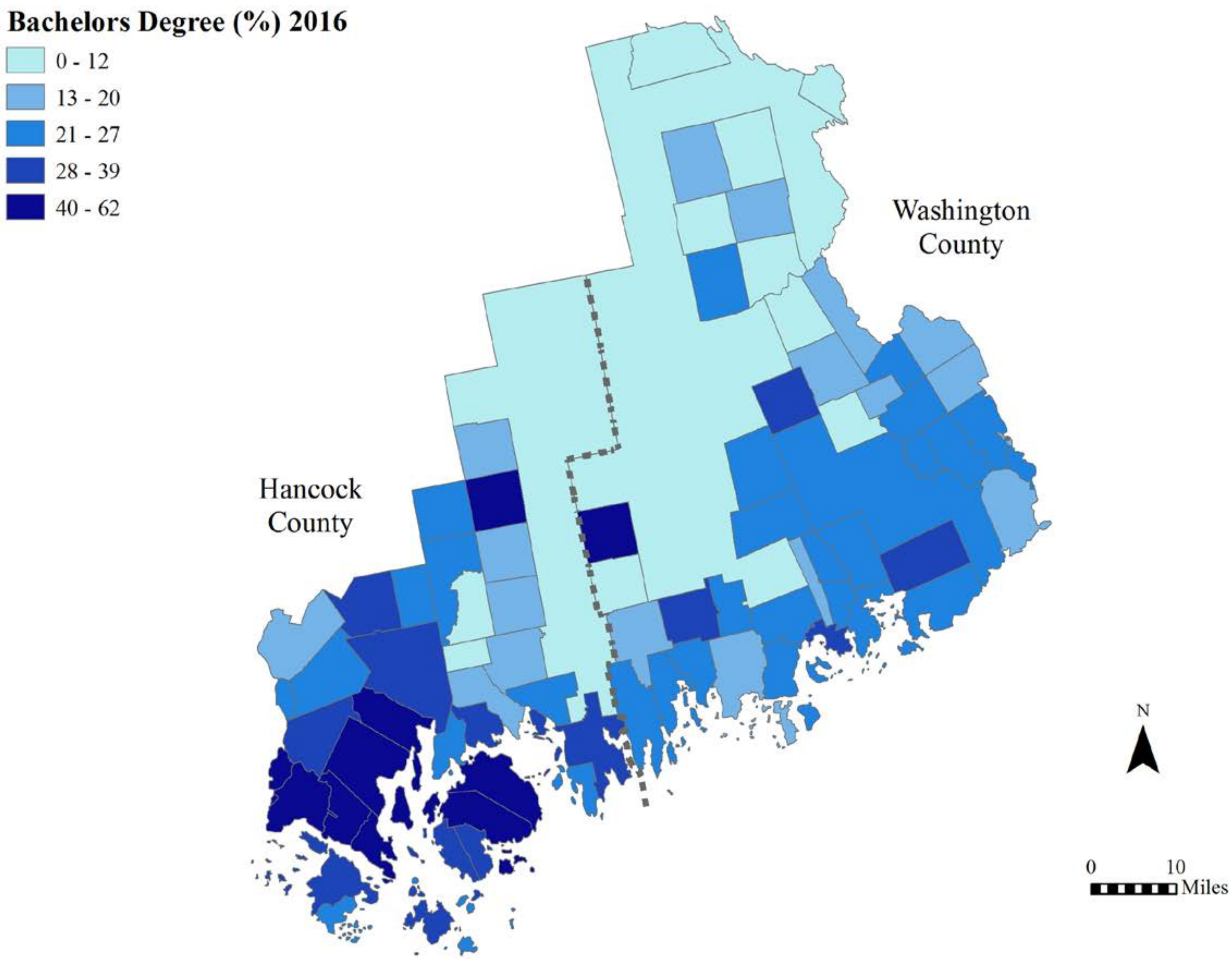

Figure A.1. College attainment in Downeast Maine, 2016.

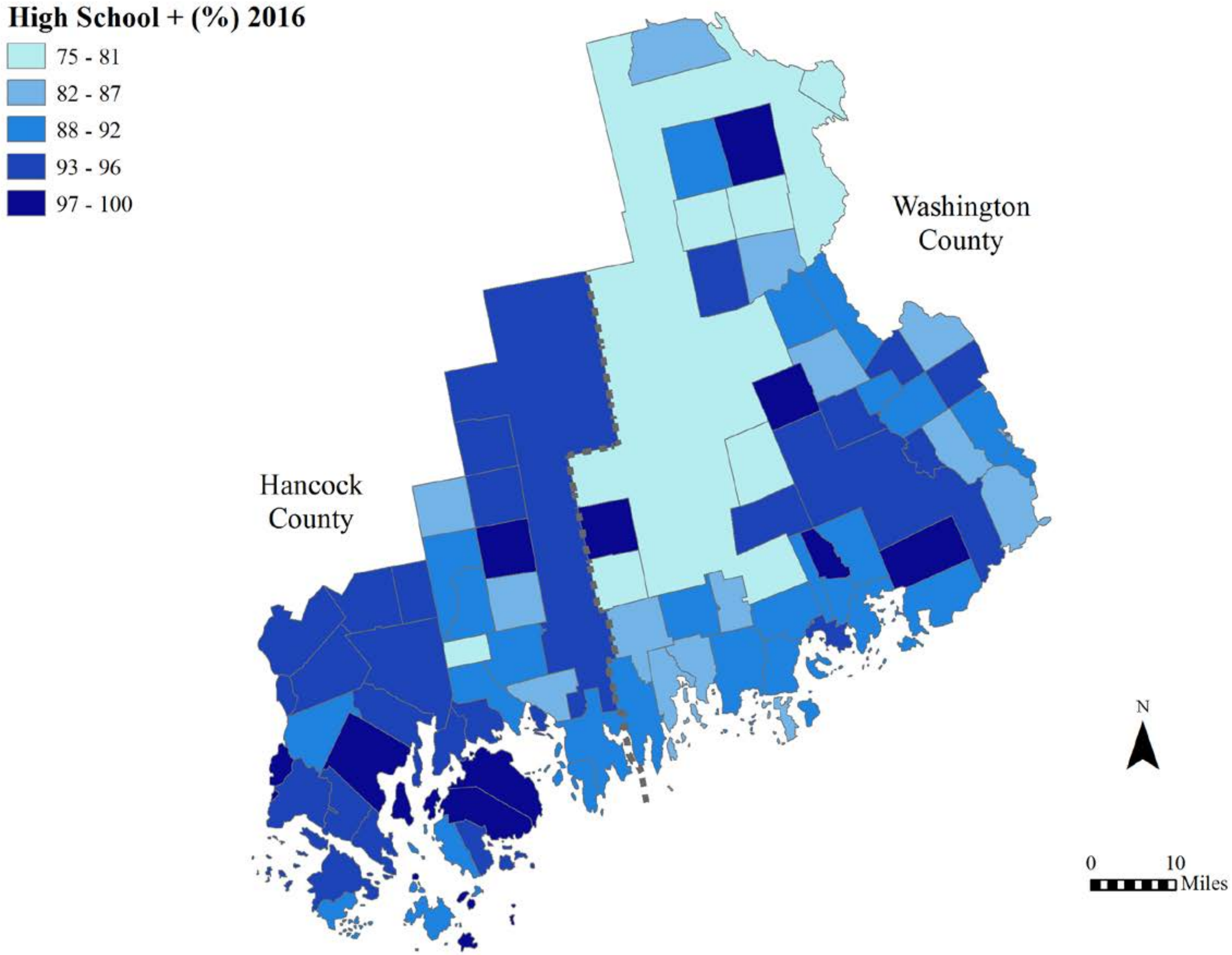

Figure A.2. High school diploma attainment in Downeast Maine, 2016.

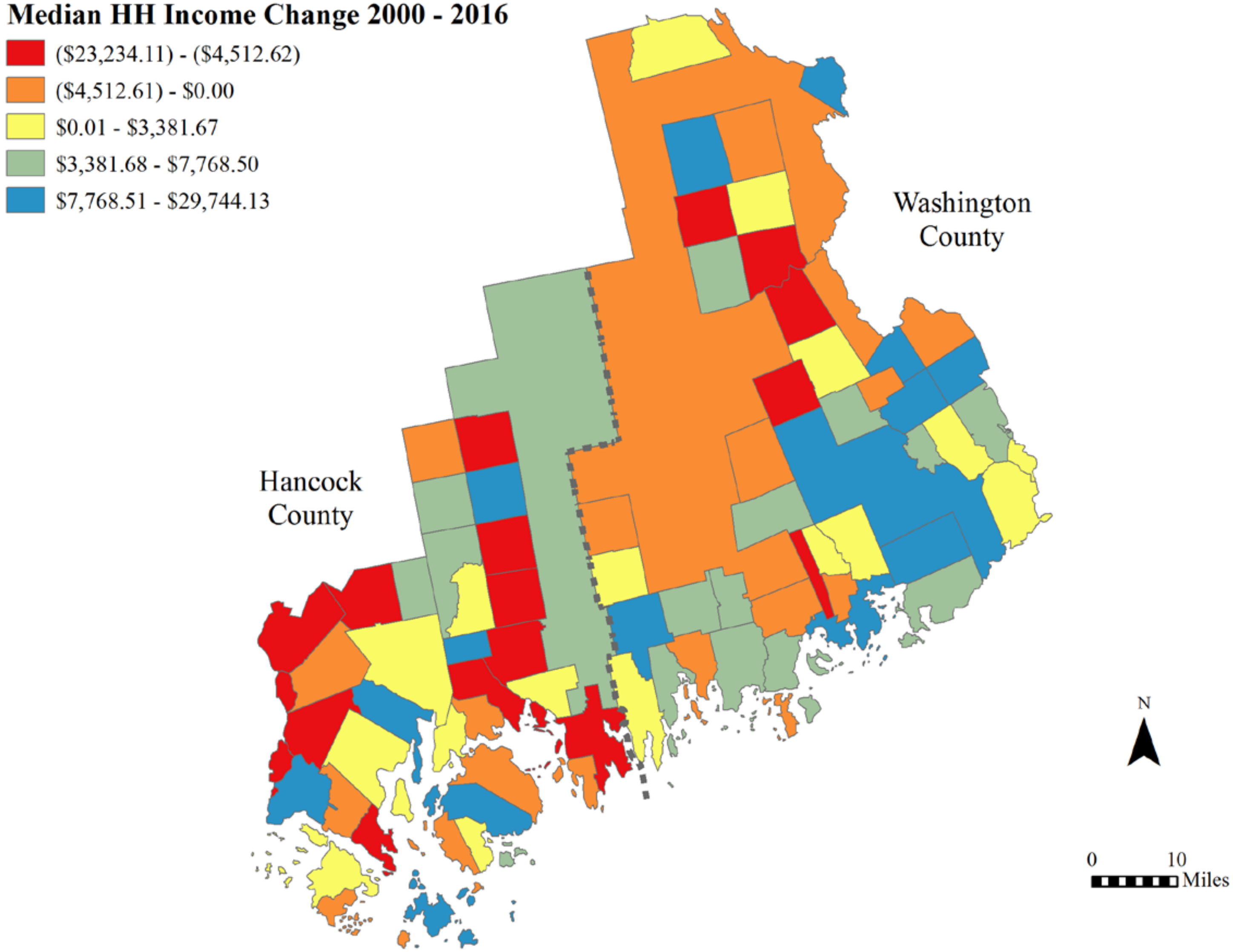

Figure A.3. Median household income change, 2000 – 2016.

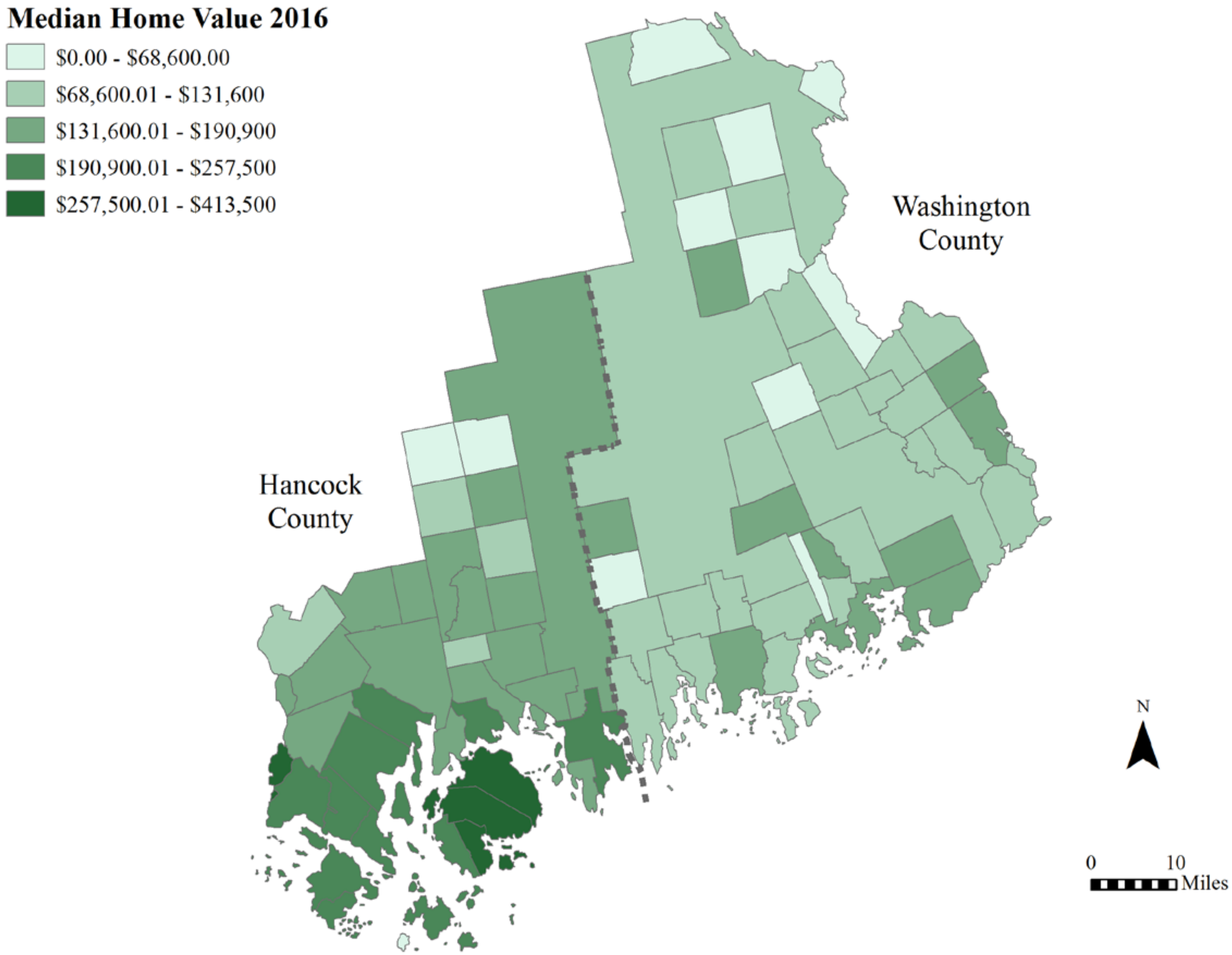

Figure A.4. Median home value in Downeast Maine, 2016.

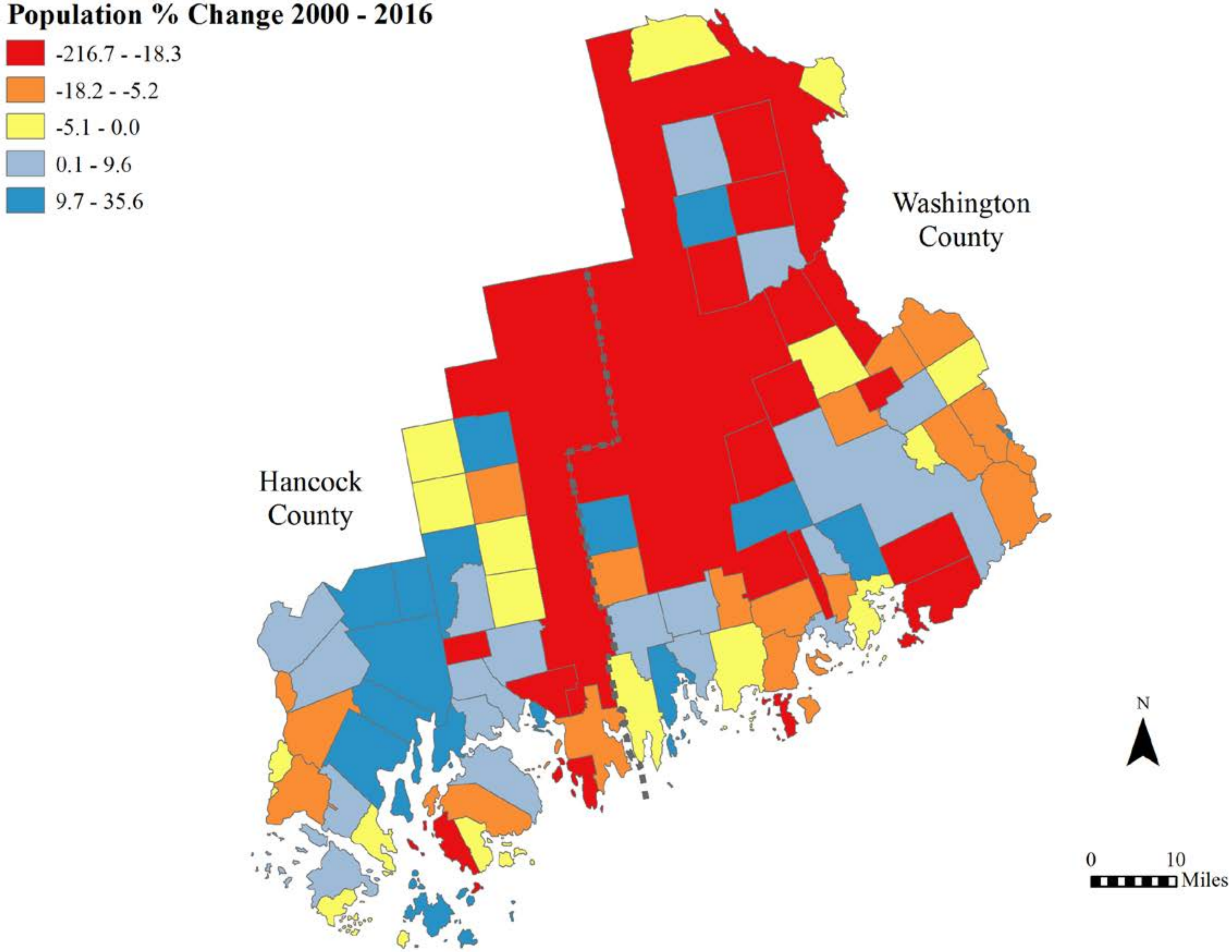

Figure A.5. Population change in Downeast Maine, 2000 – 2016.

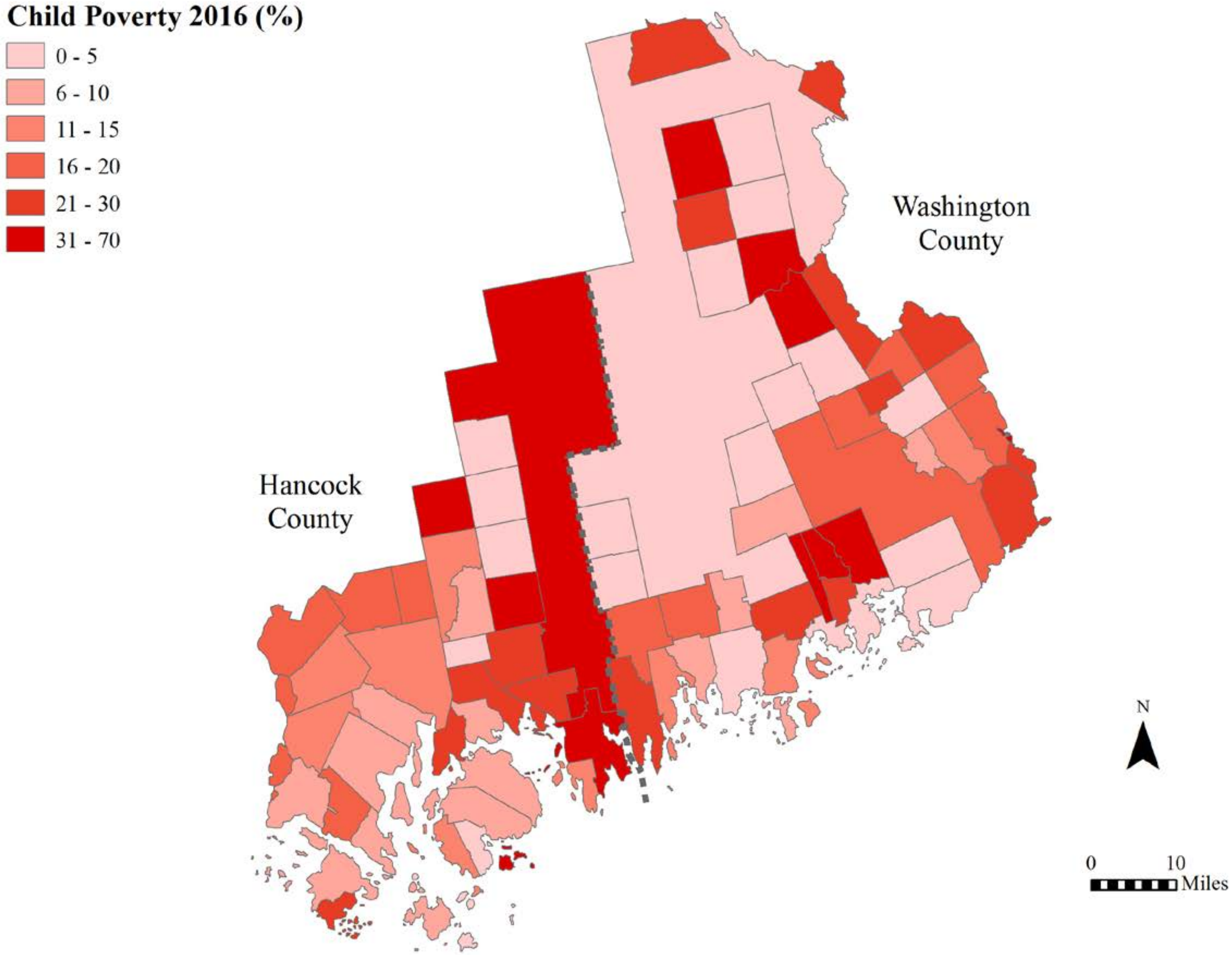

Figure A.6. Child Poverty Rate in Downeast Maine, 2016.

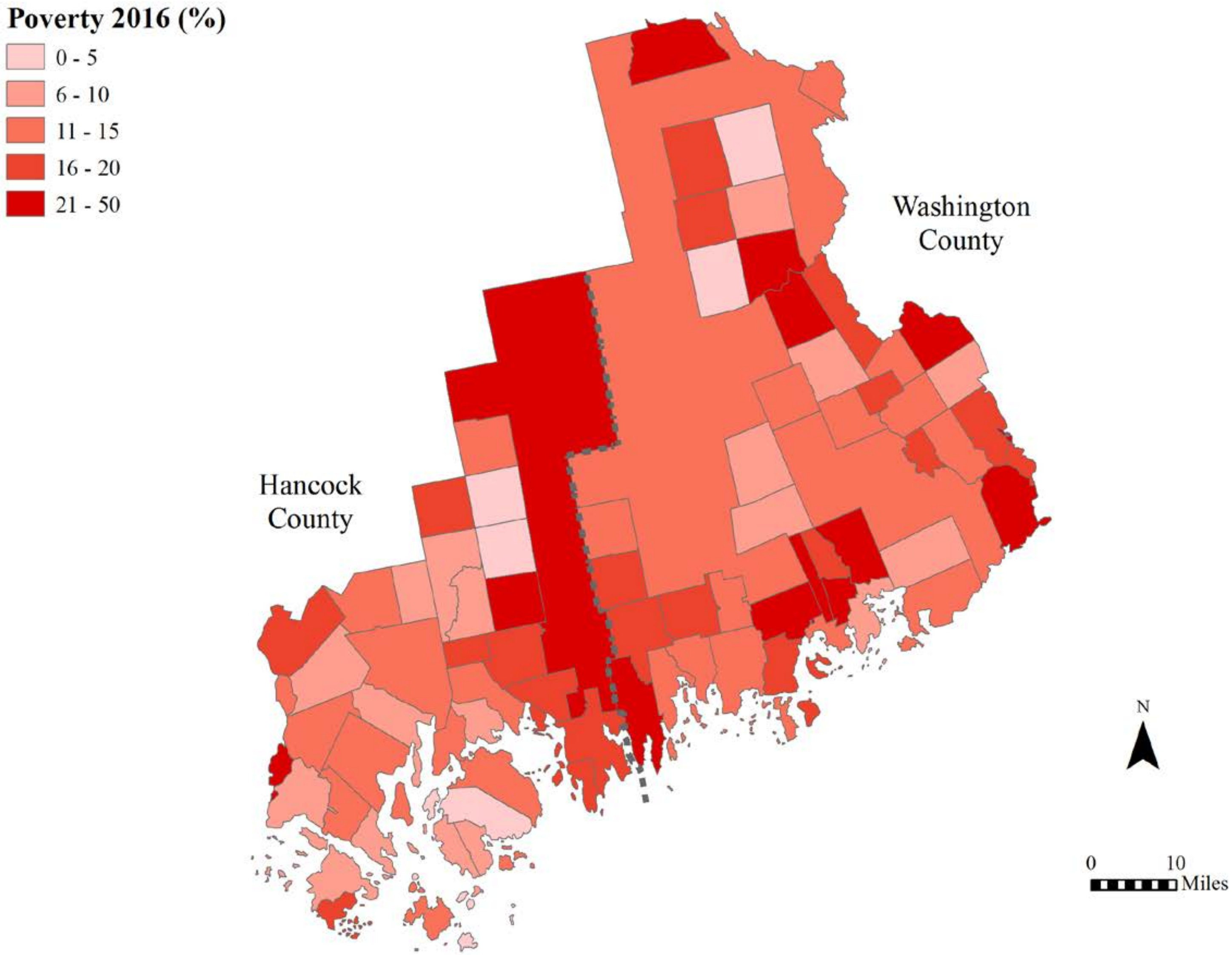

Figure A.7. Poverty Rate in Downeast Maine, 2016.

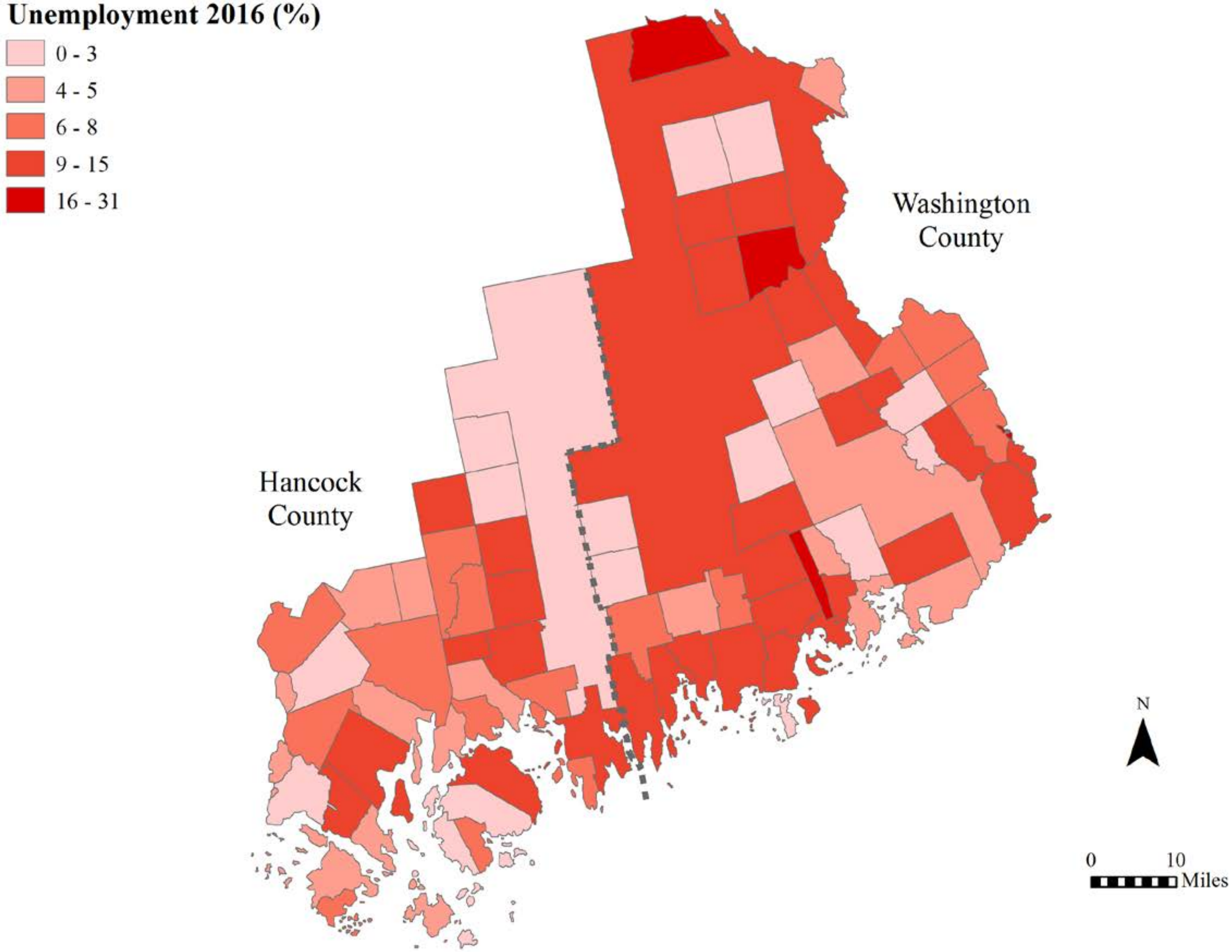

Figure A.8. Unemployment Rate in Downeast Maine, 2016.

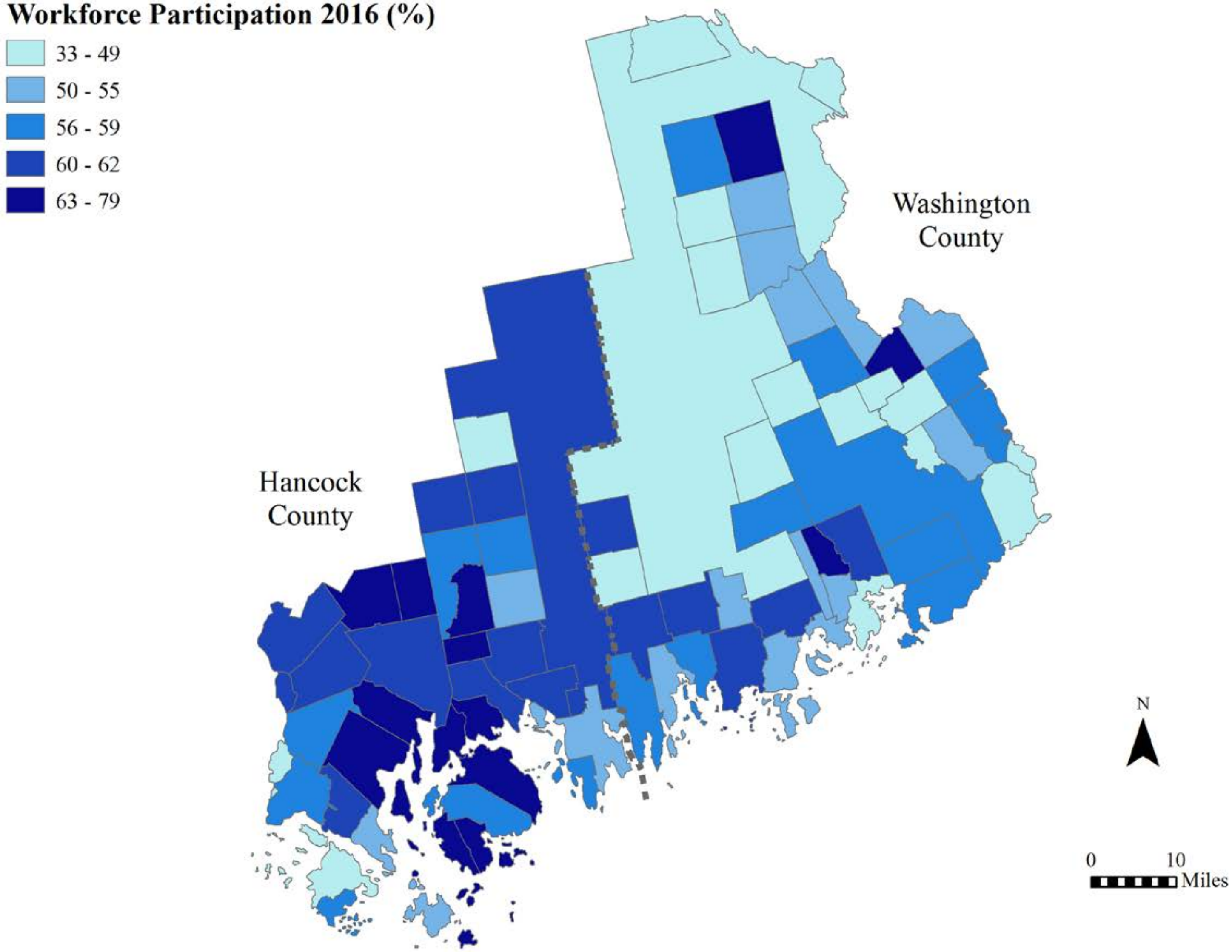

Figure A.9. Workforce Participation Rate in Downeast Maine, 2016.

BIOGRAPHY OF THE AUTHOR

Lesley Lichko was born in Charleroi, Pennsylvania on February 1, 1966. In 1984 she graduated from Toms River High School South in New Jersey. She went on to earn a B.S. in Agriculture from the University of Delaware in 1988, where she majored in animal science and minored in psychology.

Lesley's lifelong passions have been music and animals. She spent the early part of her career working for animal welfare organizations, including the Massachusetts SPCA and Peninsula Humane Society (California). The Bangor Humane Society brought her to Maine in 1996, where she was Director of Operations until deciding to return to graduate school.

In December 2001, Lesley earned a master's degree from the University of Maine in Ecology and Environmental Science. Her research focused on wetland mitigation, specifically, vernal pool creation and design. A portion of her results (An Evaluation of Vernal Pool Creation Projects in New England: Project Documentation from 1991–2000) were published in 2003 in the journal *Environmental Management* (Vol. 32, No. 1, pp. 141-151).

Upon completing this degree, Lesley began a career in nonprofit fundraising, working as Development Director for Haystack Mountain School of Crafts, and later in major gift fundraising for Bates College and Husson University. In August of 2016, she returned to the University of Maine to study in the School of Forest Resources.

Lesley is the mother of one daughter, Stephanie, an undergraduate at the University of Maine. She is a candidate for the Master of Science degree in Forest Resources from the University of Maine in May 2019.